Heating and Ventilating

For Engineers and Contractors Controlling the Design, Specification, Installation and Maintenance of Heating, Ventilating and Air Conditioning

Volume 30 | FEBRUARY, 1933 | Number 2

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Published Monthly by

THE INDUSTRIAL PRESS, 140-148 LAFAYETTE STREET, NEW YORK

ROBERT B. LUCHARS, President | EDGAR A. BECKER, Vice-Pres. and Treasurer | ERIK OBERG, Secretary
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Selling Modernizing By Guaranteeing High Return on Investment

By G. KENDRICK BRINGHURST†

THE independent engineer, in order to continue to exist as such during the present period of very little or practically no new construction, must bestir himself as never before to find or to create work.

Two distinctly different fields of engineering are open to him:

(1) the rehabilitation of existing construction, and (2) federal construction, where the commission for making the design has been awarded to a private firm of architects or engineers.

We will consider the rehabilitation of existing buildings. If the engineer can show the owner of a building that by making certain changes or additions to his existing mechanical plant, his operating costs will be reduced, and the cost of making these changes can be paid for in the resulting savings of a few years' time, then the owner may be convinced that the engineer's recommendations are worth while, and it will be to the owner's advantage to make the changes at this time when construction costs are at their lowest.

From my experience, it seems that, at present, most owners insist on being guaranteed a return on their investment of not less than 50% before they will proceed. They cannot foretell how long they will be able to hold their properties, and for that reason they say any investment which would not show a good return in one year, and pay for itself in two years, would not be worth considering. On the other hand, where the property is taken over by the mortgagor, if the latter happens to be a trust company or a bank, there is more likelihood of improvements being made, and the immediate paying off on the investment is not so great a consideration.

The logical prospects to approach, therefore, are the banks and trust companies whose holdings include buildings which, although adequate for their particular use, are at the same time operated in a comparatively wasteful manner because of antiquated or worn-out equipment. Loft and office buildings, hotels, apartment houses, warehouses and factories are included in this category, as are all types of manufacturing and industrial plants.

In communities where street steam is sold, the local utility company will naturally endeavor to sell their product wherever possible. The services of an independent engineer should be of immense value to the prospective purchaser of steam, in order that the latter will have an unbiased opinion before he decides to scrap his boilers in favor of purchased steam. In my opinion, a report submitted by a utility company should be analyzed by a competent engineer before any owner decides to make a change.

Most owners are so chary of spending money for engineering services, especially now, that in many cases

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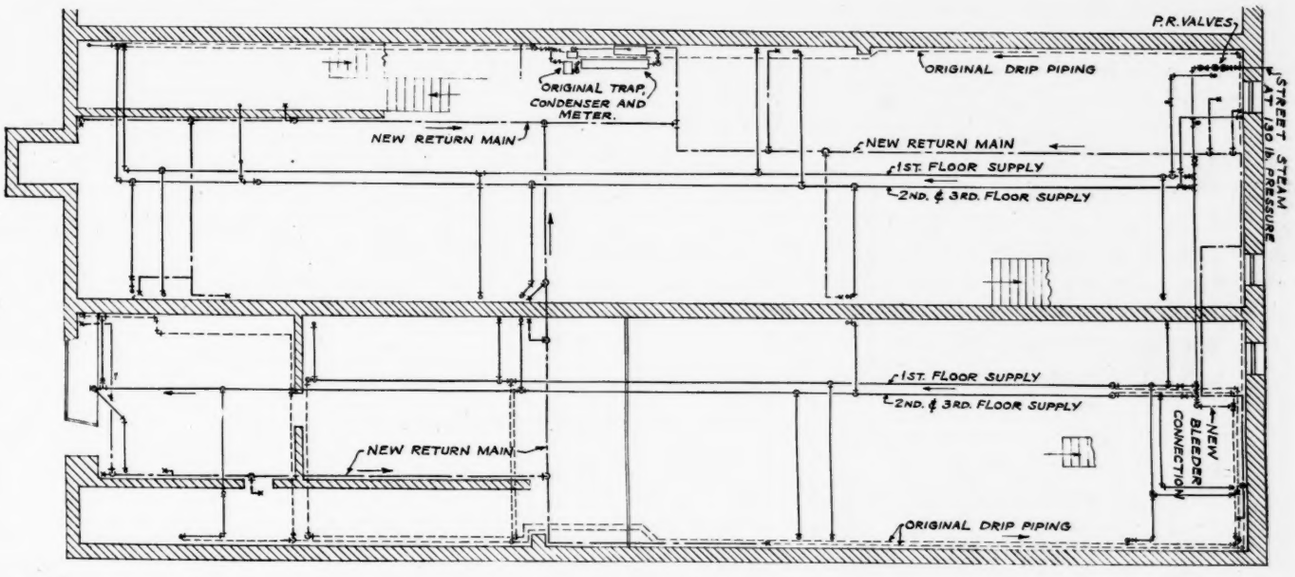


Basement plan of building described in Case 1. Note duplicate supply mains in each basement and long runs of drip piping, all of which was included in the utility company's charge for installed radiation.

the engineer will have to agree to make his investigation and report at no cost or at a very small cost to the owner, provided, however, that in the event the work goes ahead he will then receive his full fee.

Let us now consider some typical cases.

Case 1—Owner Gets 55% Return on Investment

A three-story twin building heated by street steam. It contains 17,960 sq. ft. of floor area, is heated with 2150 sq. ft. of equivalent direct radiation, of which 1700 sq. ft. was cast iron and the remainder piping, covered and uncovered. The cost of the purchased steam averaged $1535 per heating season of eight months, or at the rate of 8½ cents per sq. ft. of floor area.

The building is operated by a trust company, whose real estate department paid the bills with no thought that the amount of steam consumed was excessive. The one-pipe, upfeed piping system had been in use for 20 years, and had two supply mains in each building, running the full length of the basement ceilings. Due to inadequate bleeding, these mains were constantly flooding the system with water, necessitating periodic draining.

Basements and first floors are occupied by furniture dealers, and the excessive pipe radiation in the basements played havoc with glued joints and caused warping of woodwork.

Upper floors are occupied by a photograph studio and tailoring firms, occupants of which complained of a lack of heat when the system filled with water, and too much heat at other times.

Frequent complaints were made by the tenants, and we were called in to see what could be done about equalizing the temperatures, and found conditions as outlined above. When we inquired the cost of steam and were told $1535, we knew something was wrong. The steam utility's radiation charge was based upon the amount of equivalent direct radiation installed, and their use charge upon the quantity of steam metered. We recommended, therefore, that 400 sq. ft. of cast iron be removed in rooms which were over-radiated; that a small amount of additional radiation be added in certain other rooms, all radiators to be equipped with thermostatic traps and the condensate connections run to a basement return main; bleeding of the supply mains where necessary; insulation of all uncovered supply piping, and finally the installation of a motor-operated valve in the main supply, controlled from a thermostat in the office of the most responsible tenant.

Under the original layout, all drip piping was included in the radiation charge up to the point where it discharged to the sewer through a float trap and condenser. Under the new layout, however, with all radiators trapped, the drip piping cannot be included in the radiation charge.

Logical prospects to approach are the banks and trust companies

These recommended changes were approved, and made at a total cost of $1250, including engineering fee, and the annual saving of $689 indicates a return on investment of 55%, distributed as follows:

	E. D.R.	Radiation charge	Use charge	Total
Formerly	2150	$671	$864	$1535
At present	1600	506	340	846
Saving		$165	$524	$ 689

These savings do not include cost of contractor's services which are not now required, or the previous cost of repairs to stored furniture damaged due to excessive changes in temperature. The radiation charge of the steam company, their retail rate, was 32 cents per sq. ft. for the first 1300 sq. ft. of E.D.R. and 30 cents per sq. ft. for the balance, and the use charge at 45 cents per 1000 lb. of steam metered. Covered piping was considered as 15% of its radiating surface.

In addition to eliminating waste of steam, and balancing the temperatures as actually required for the comfort of the tenants throughout the building, the revised layout corrects former piping troubles, thereby saving the cost of contractor's services which formerly were fairly constant.

If the basement had not been rented, it might have been advisable to install an automatically-controlled oil-burning boiler.

The point which we wish to bring out is that the trust company had no idea they were paying twice the amount necessary for heating; their complaint was with the piping system which required so much attention and the fact that the tenants were not being satisfied. They know now that it paid them well to engage engineering services, and have since called upon us in connection with other of their holdings.

Case 2—Owner Invested $4650; Saves $2000 per Year

Agents for a loft building in the center of the business district asked for a check on maintenance costs which were increasing each year at what they considered to be an alarming rate. They did not think their coal consumption was excessive.

Nine stories high, with stores on the first floor, the building contained 56,500 sq. ft. of floor area, heated with 7660 sq. ft. of equivalent direct radiation made up mostly of wall coils, with a small percentage of cast-iron radiators.

Two H.R.T. boilers, rated at 165 hp. each, burning semi-bituminous coal, had been installed 40 years ago, part of the original layout which was used to generate power and light for the building. Subsequently, electricity was purchased and the engine generators removed, but the original exhaust piping remained, and into this the steam for heating was now introduced.

The heating system was downfeed, two-pipe, gravity return to a feed water heater and steam-driven boiler feed pump. According to the stationary engineer, it was necessary for him to be on the job at 6 a.m. each morning and work the boiler pressure up to 30 or 35 lb. in order to get the building heated by the time the tenants arrived. After this, 5 or 10 lb. pressure was required. Both boilers had just been retubed, and, considering their age, were in fair shape.

Piping throughout the building was in a deplorable condition, necessitating constant repairs. In some cases, pipe coil radiation was sagging badly or had been disconnected altogether. There was a large radiation loss from the uncovered basement piping, particularly the large amount of exhaust piping.

Radiation on the different floors was badly proportioned, resulting in unsatisfactory heating, in some cases being only about 35% of the amount theoretically required. Four floors were unoccupied and on these most of the radiation had been turned off.

Coal consumption of 400 tons per season, based on the 6200 sq. ft. of E.D.R. actually in use, was at the rate of 6½ tons per 100 sq. ft. of E.D.R.

We recommended the installation of an entirely new system of piping, relocation and addition of certain radiation, with thermostatic traps throughout, elimination of the feed water heater and steam-driven feed pump, addition of boiler return and vent traps, insulation of all supply piping. We figured that a fuel saving of at least 40% could be effected.

The annual saving in cost of operation was estimated as $782 for coal, $60 for ash removal, and savings in labor, $936 per year, a total of $1778.

We recommended the installation of an entirely new system of piping

When the cost of repairs and replacements to the old installation was also considered, and these would probably have increased each year, the total annual saving figured to be in excess of $2000.

As the total cost of the work of rehabilitation was $4650, the return on investment was better than 43%.

Case 3—Owner Modernizes, Gets 40.2% Return

While visiting a loft building we heard the superintendent of the building complaining about the high cost of operation, particularly in regard to purchased steam. After an introduction, we offered to survey and report on the mechanical installation, at no cost, provided, however, that a full fee for engineering services was paid if the report was acted upon favorably. The superintendent agreed to this proposal.

The building was eight stories and basement, contained 121,000 sq. ft. of floor area, heated by 22,260 sq. ft. of E.D.R., of which 20,240 sq. ft. was cast iron. Heating system was upfeed, two-pipe steam, with gravity return to basement receiver from which the condensate was raised into the main sewer by a very ineffective steam pump. Supply piping was insulated.

During the preceding year, cost of purchased steam, wholesale rate, was $10,556, made up of 10,087,000 lb. for heating, and 3,920,000 lb. for use in tailoring irons at 100-lb. pressure. The division of cost was $6809 for heating, or at the rate of 5⅝ cents per sq. ft. of floor area, and $3747 for high-pressure work.

The building was 24 years old, owned and operated by a trust company which could well afford to make expenditures showing a fair return on the investment. A careful survey indicated that the amount and placing of radiation was theoretically correct, that the building was well constructed, with few air leaks, and the piping appeared to be in good condition. It was obvious, however, that by making certain changes in the layout, savings in steam consumption could be effected.

Estimates of operating costs with boilers, and costs of installation were calculated, and reports submitted covering several different propositions:

A. Boiler plant for heating only, continuing to purchase steam for high-pressure requirements. (This case was considered at the request of the superintendent.)

B. Boiler plant for both heating and high-pressure requirements, burning rice coal at $5.25 per ton.

C. Boiler plant for both heating and high-pressure requirements, burning fuel oil at 3 cents per gal.

D. Continuing with purchased steam, but modernizing existing heating system.

The cost of making the proposed changes in each case was carefully estimated, and the annual operating costs calculated. The savings resulting from the improvements were then determined, with the following results:

	A	B	C	D
Cost of installation....	$11,500	$13,940	$16,800	$4,360
Annual operating costs..	3,850	4,950	4,176	4,815
Annual savings	2,959	5,606	6,380	1,994
Return on investment ..	25.7%	40.2%	37.8%	45.7%

Modernization of the heating system, with radiator traps, etc., and automatic control regulated according to outdoor temperatures and the requirements of tenants, was included in each case. Annual operating costs included fuel, fireman's wages and ash removal for Cases A and B, fuel and electricity for Case C, and purchased steam for Case D. Interest and depreciation were included for each case.

The accumulated savings over a period of years, taking into account the installation costs, were estimated to be:

	3 years	4 years	5 years	6 years
Case A			$336	$3,295
Case B	$2,878	$8,484	14,090	19,696
Case C	2,340	8,720	15,100	21,480
Case D	1,622	3,616	5,610	7,604

According to this tabulation, the oil-burning plant would seem to be the best investment. The higher first cost, as compared to coal-burning boilers, was offset by the fact that additional labor for coal firing and ash removal would not be required, there would be none of the resultant dirt and dust from coal and ash handling, basement storage for coal and ash would not be needed, and the annual cost of fuel would be appreciably less. A licensed engineer was employed at the building, so there was no additional cost involved in this respect.

The owners, however, were not sold on fuel oil burners, and this fact, together with the difference in first cost between the coal and oil-burning installations, amounting to about $3000, governed their selection of the installation of Case B.

Case 4
Owner Spends $2800, Saves $1728 per Year

The owners of a five-story office building, with stores on the first floor, were interested in having an investigation made of their heating costs, if they could defer the payment of the engineering fee until such time as any recommended changes in the installation were made.

The building contained a total of 34,500 sq. ft. of floor area, with 4700 sq. ft. of E.D.R. installed. Street steam for heating cost $1932, wholesale rate, during an unusually mild season, which, figured on the basis of an average heating season, would be in this case 20% greater, or $2318, amounting to 6¾ cents per sq. ft. of floor area. The heating system was two-pipe steam, upfeed, with thermostatic traps at all radiators. All supply piping was uncovered.

We recommended a full automatic oil burner and insulation of all supply piping

We recommended the installation of a full automatic oil-burning boiler, and the insulation of all supply piping. With fuel oil no additional labor would be required, as the janitor of the building was capable of checking the burner operation.

Estimate of first cost was $2800, annual operating cost $620, annual saving $1,728 (based on average heating season), with return on investment 60%.

The owners, however, were not anxious to spend the money, until something occurred which caused them to change their minds rather suddenly. The street steam entered the building at 130-lb. pressure and was reduced to 5 lb. inside the basement wall. Only one reducing valve had been provided, and no relief valves. Steam was turned on at the start of the heating season, and when the reducing valve stuck, and the full line pressure reached the first radiator in front of a show window in a first floor store, it was just too bad. The radiator was blown to pieces and considerable damage done. The tenant narrowly escaped serious personal injury and threatened to sue the owners. The owners then and there decided to own and operate their own heating plant, which, as has already been pointed out, could be done without the hiring of any additional labor.

Case 5—Steam Consumption Reduced from 54 Million to 32 Million Pounds

It was formerly the fashion to use steam-driven pumps for hydraulic operation of elevators in office buildings and hotels, utilizing the exhaust steam for heating and hot water. We know, however, that these pumps are usually "steam hogs" and a large amount of the exhaust is wasted, particularly during the summer months when no heating is required.

In a 15-story office building, equipped with six elevators, the average of several 24-hr. tests revealed that for a travel of 82.6 car miles, the steam consumption of two duplex pumps was 74,900 lb. The average yearly travel of 24,580 car miles (recorded by automatic counters) was at the rate of 81.9 car miles per day for 300 equivalent full days, a good check, and the annual steam consumed by the pumps was estimated to be

$$\frac{74,900}{82.6} \times 24,580 = 22,290,000 \text{ lb.}$$

The pumps had been in use for more than 25 years, and were a constant source of annoyance to the owners.

Other steam consumers in the power plant of the building included the engine generators for lighting service, house and boiler feed pumps, air compressors for sewage ejection, and the vacuum pump for the heating system.

The annual steam requirements, based on 24-hr. tests, and figured for 300 equivalent full days per year, for all but the vacuum pump which was in use during the heating season only, were as follows:

Elevator pumps	22,290,000 lb.
Engine generators	16,949,000 "
House pumps	4,389,000 "
Feed pumps	3,782,000 "
Air compressors	2,252,000 "
Vacuum pump	713,000 "
Live steam makeup	1,944,000 "
Waste, leaks, etc., 3%	1,618,000 "
	53,937,000 lb.

The amount of live steam makeup for heating and hot water generation required from 11 p.m. until 9 a.m. during the heating season of 180 equivalent full days, was calculated from the test results of steam required and supplied for each of these 10 hr. During the balance of the time, the amount of exhaust steam available for heating and hot water exceeded the amount required.

The annual coal consumption was 3,644 tons of No. 1 buckwheat. Boiler evaporation was therefore $\frac{53,937,000}{3644 \times 2000} = 7.4$ lb. water per pound coal, which checked very closely with the results of 24-hr. boiler tests, and indicated that the assumption of 3% to cover waste, leaks, etc., was substantially correct.

Further calculations showed that only 51% of the total annual exhaust was utilized, and of the 49% wasted, more than one-half occurred during the five months when no heating was required.

Therefore, by substituting motor-operated pumps for the steam-driven elevator pumps which consumed 41% of the total annual load, it would be possible to effect savings, as the exhaust steam not utilized would then be about 18% of the exhaust available.

This had to be an economical installation with the lowest possible first cost, and included the replacement of the reciprocating pumps with new centrifugal units operated with 2200-volt purchased current carried directly to the unit motors, and the retention of the old steam pumps as spares.

Under these conditions, the annual steam requirements were:

Engine generators, 16,949,000 lb.; house pumps, 4,389,000 lb.; feed pumps, 2,274,000 lb.; air compressors, 2,252,000 lb.; vacuum pump, 713,000 lb.; live steam make-up, 4,928,000 lb.; waste, leaks, etc., 974,000 lb. Total, 32,479,000 lb., and the coal consumption, $\frac{32,479,000}{7.4 \times 2000} = 2195$ tons.

Comparing the costs of operation under the old and new conditions:

	FORMERLY	PRESENT
Fuel, @ $5.95 per ton	$21,682	$13,060
Ash removal, @ 30c.	1,093	659
Labor, power plant	13,988	12,948
Oil, waste, supplies, etc.	1,114	905
Purchased current, power service		5,659
	$37,877	$33,231

Annual saving, $4,646.

The total cost of the new work, including the pumps, motors, electrical receiving equipment and controls, conduit, piping, installation, etc., and including engineering fee, amounted to $9,785. Including interest and depreciation, the return on investment was better than 40%.

It would of course have been possible to show additional savings by electrifying the other steam-driven equipment, and modernizing the old heating system, but the amount of money available at this time was limited.

These five examples show what can be done in selling the idea of modernizing to building owners. It might be emphasized that there is no better way of approaching the owner than by talking savings to him.

Air in Industry

Air is an all pervading factor in industry, in health, and in life itself. Few employers are aware of the need of maintaining the air conditions in the plant on a basis favorable to the human body and to the energy of the worker.

Temperature is only one factor either in comfort or productivity. A constant temperature is constant when only in a still atmosphere; as the velocity of the wind increases, the body tends to cool. Thus a temperature of 65° feels more oppressive than one at 75° if there is no air movement. It is not generally known that external air moves at a rate averaging about 13 m.p.h., and in general, this means comfort but it is difficult to maintain a satisfactory air movement in the workshop, although there is a great need for air movement in the work place. First, because the worker is usually actively engaged, and, secondly, because his operations create dust which should be removed from the air he breathes. Thus, there is a double need for ventilation, and, because of the character of the dust, it is often necessary to remove it at the point of origin. Much can be done by the worker, however, to avoid the creation of dust, and to avoid the breathing of it when generated. If he is surfacing stone, for instance, he can avoid breathing the air by standing between the stone and the wheel. The worker should understand the undesirability of breathing in impure air, but he should be certain to avoid certain classes of dust which clog up the lungs or poison them.

Another essential in the maintenance of good air conditions is the reduction of the humidity when high. This can be accomplished by either drying the air or by increasing the air movement which makes the humidity less apparent. The success of some employers in bringing about ideal conditions has been wonderful when the needs of the product are taken into account. In the cotton mills you will find exotic conditions because the cotton can be worked to best advantage in them. Even in the storage of steel sheets, great storage rooms are provided with a temperature and dryness that is remarkable. But when it comes to providing the most favorable conditions for the workers, employers have an unhappy way of feeling that they are being asked to do the impossible. They complain of the cost. They do not seem to realize that a good working temperature is often a positive economy. It keeps the worker in good humor; it helps to produce more work and it lessens the possibility of accidents. — *From The Industrial Bulletin, Division of Industrial Hygiene, New York State Department of Labor.*

Steam Ejector Refrigeration

FROM the standpoint of the engineer designing air conditioning systems and of the heating contractor who installs them, the revival of the steam ejector system of refrigeration is significant. Recent developments indicate that no inconsiderable part of the cooling business in future air conditioning work will consist of applications of this old-new system.

Looking at the steam ejector refrigerator through the eyes of the designer, some advantages of the method are its low first cost, moderate space requirements, and flexibility. The piping contractor, on the other hand, is attracted because he is familiar with the properties of steam and, if he has had no previous experience with other systems of refrigeration, finds he can better understand this system. This is particularly true because the installation problems involved with the steam ejector include almost nothing except the installation of water and steam piping. The operating engineer observes the flexibility of the method—particularly important in the case of the highly fluctuating loads experienced with air conditioning for comfort—and the fact that no licensed operator is required. He notes further that no chemical refrigerants are used.

The principle of operation is simple. Under vacuum, water boils at temperatures lower than 212°. By maintaining a vacuum in a tank we can boil water into steam at relatively low temperatures. The heat required to boil the water is taken from the water itself, so that the water remaining in the bottom of the tank is cooled and can be used to cool air. The problem is, of course, to maintain the vacuum in the tank.

Referring to Fig. 1, the vacuum tank is shown at the left. The water to be cooled enters at the top, the cooled water leaving at the bottom. Connected to the vacuum tank is a steam jet connected to a steam source at 10-lb. pressure or over. The velocity of the steam through the ejector causes it to entrain or induce the flow of the flash steam from the vacuum tank. The resulting steam mixture is condensed in a suitable heat exchanger, the water for condensing being at the lowest temperature it is possible to obtain in quantity. A small ejector is used to remove any air which has leaked into the circuit.

The main disadvantage of the method is that a large supply of cooling water is necessary unless very cool water is available. If it is not, a spray pond or cooling tower will be necessary. One of its advantages is

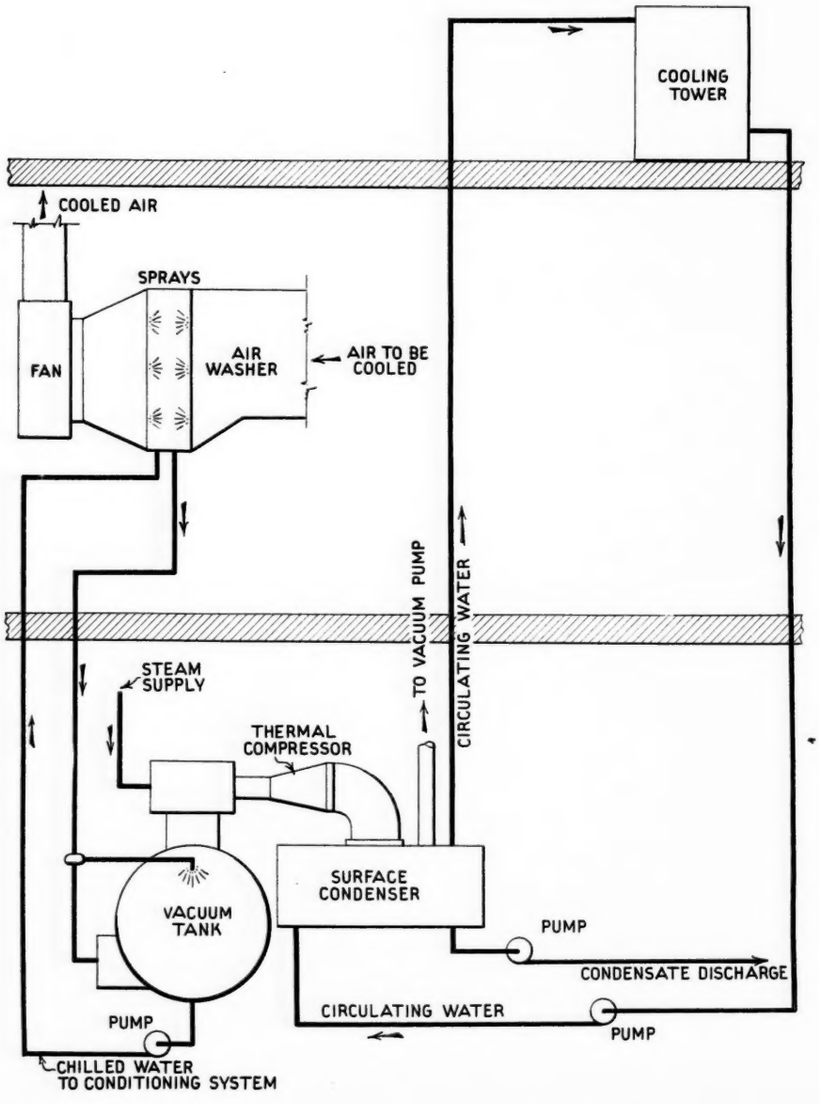


Fig. 1. Schematic diagram showing the principal parts and general arrangement of a steam ejector system for air conditioning

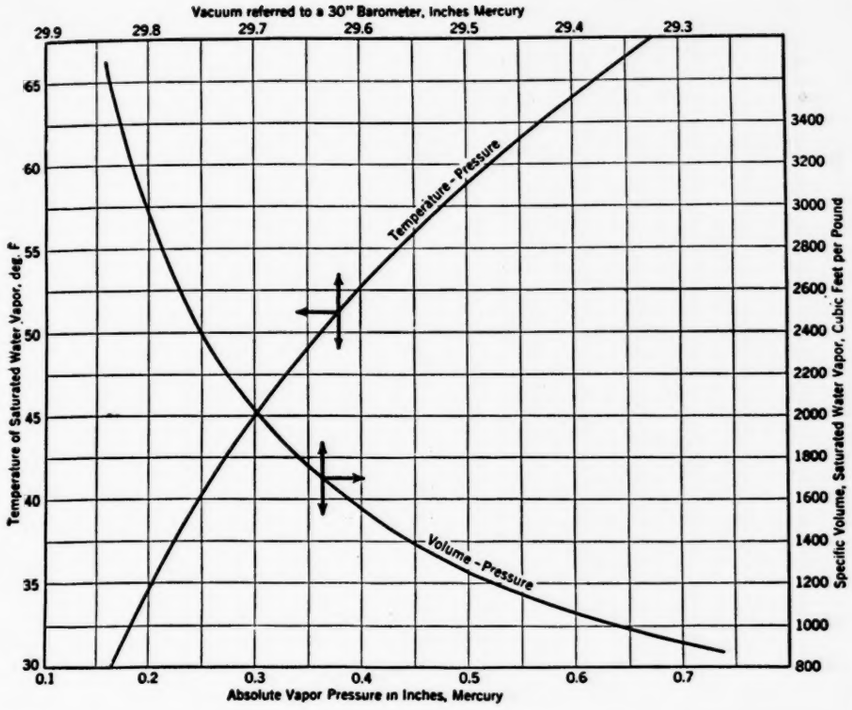


Fig. 2. Chart showing vacuum necessary to secure different final temperatures. This chart also shows cubic feet of vapor which must be removed for each pound of water which is flashed into vapor. From "Vacuum Refrigeration," an A.S.R.E. paper by D. K. Dean, Foster-Wheeler Co.

that high-pressure steam is not necessary, although the fairly high pressures are desirable.

A more thorough knowledge of the design is necessary in order properly to select and design a system employing this method. Among the points which have a great deal to do with the cost of operation are the ratio of pressures in the ejector, the temperature of the cooling water, steam pressure, and load to be carried.

At least five manufacturers have done experimental work in connection with developing the steam ejector for refrigeration, and some data are available as to the performance of such systems. Some of this material appears in the following articles, the first being a general outline of the subject, the second a study of the ejector from the standpoint of engineering calculations and costs.

Advantages and Applications

By H. M. GRAHAM*

THE primary ejector, sometimes called the booster, is the heart of the steam jet refrigeration system. It has been developed during the past 10 years for use in various refinery processes, and also has been applied to several secret processes in the chemical industry. Some of these processes require an operating absolute pressure as low as 0.08 in. of mercury, which corresponds to a vacuum of 29.92 in. referred to a 30-in. barometer. Experience has shown that the expense for repairs over a long period of years is practically negligible.

In applying ejectors to refrigeration work the study of evaporation of water under high vacuum was necessary, and experimental work and recent experience with this type of evaporator give us the design factors necessary to proportion the chamber in which the water is flashed.

To deliver 40° water from the flash chamber it is necessary to maintain a vacuum of 29.755 in. in the chamber, and at this vacuum 1 lb. of water vapor liberated occupies a volume of 2445 cu. ft. If the refrigeration unit has a capacity of 100 tons per 24 hr., roughly, 1200 lb. of vapor per hour is liberated, a total volume of 2,934,000 cu. ft. per hr. It is the ability of the steam

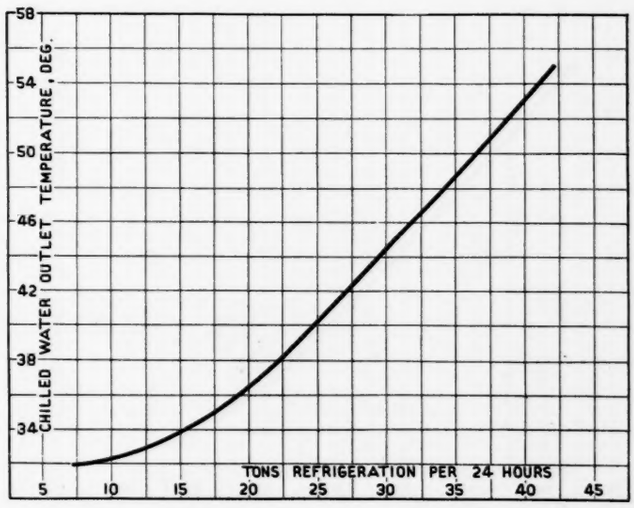


Fig. 3. Capacities of a 25 ton Ross unit at various chilled water temperatures

*Chief Engineer, Ross Heater & Mfg. Co., Inc., Buffalo, N. Y.

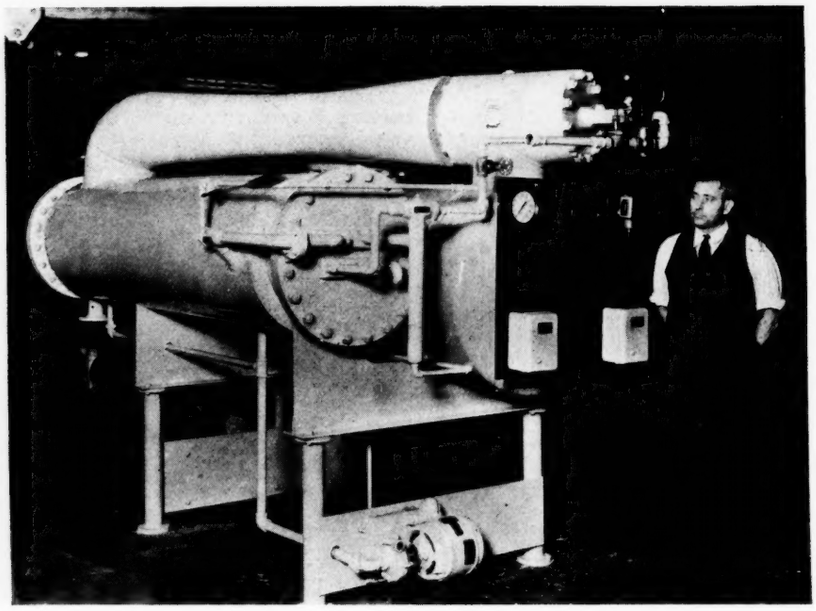


Fig. 4. The 25 ton unit whose characteristics are shown in Fig. 3.

jet ejector to efficiently handle these enormous volumes that makes the steam jet system of refrigeration practical.

In the following table are shown the vacuums which must be maintained to obtain various water temperatures, together with the specific volume of the flash steam:

Water Temperatures, °F.	Vacuum in Flash Chamber, In. of Hg.	Specific Volume of 1 lb. of Water Vapor Cu. Ft.
25	29.870	4800
30	29.838	3800
35	29.800	2950
40	29.755	2445
45	29.700	2034
50	29.640	1705

The higher the vacuum that is maintained in the flash chamber, the lower will be the water temperature leaving the flash chamber. The higher the vacuum maintained, the more steam will be required to operate the primary ejector.

Operating Steam Pressures

The higher the steam pressure, the less steam that is required for any given duty. The ejectors are available for any steam pressure from atmospheric up to 400 lb. per sq. in., but have generally been installed for pressures from 80 lb. to 125 lb.

A unit operating with 10-lb. steam pressure requires approximately twice as much steam for the same duty as one operating on 100-lb. steam pressure, but the operation of one is equally as good as the other as far as reliability and steadiness of operation are concerned.

The Condenser

The steam used to operate the primary ejector and

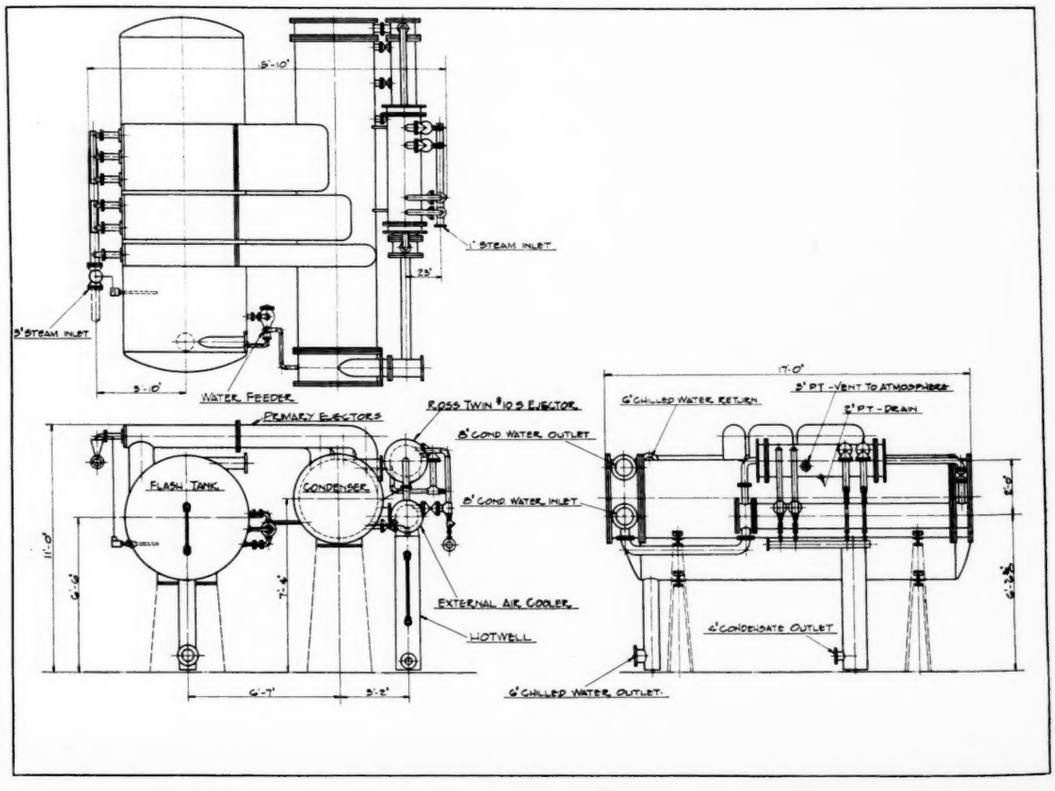


Fig. 5. General arrangement of a 180 ton unit rated at 45°

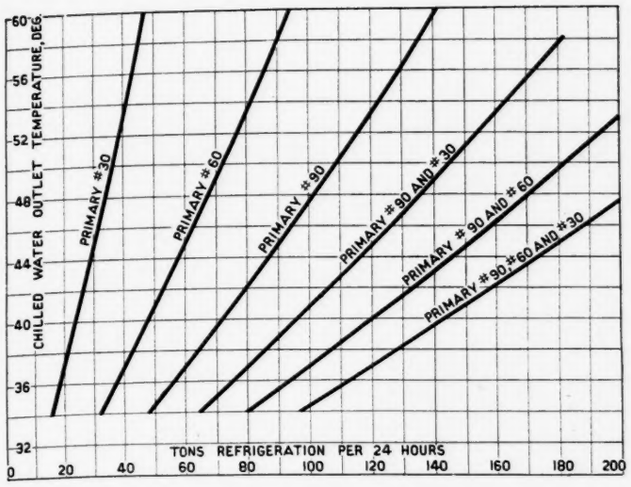


Fig. 6. Operating characteristics of the unit shown in Fig. 5. One of these units will be installed in the First National Bank Building, New York

the water that is evaporated in the flash chamber are carried over and condensed in the condenser, which may be of the surface low level jet or barometric type.

The higher the vacuum carried in the condenser, the less steam will be required, but the condenser will require more condensing water and the first cost of the installation will be more.

In general, where condensing water is plentiful, such as alongside a river, a large quantity of condensing water should be used to cut down the steam required to a minimum, and also to cut down the first cost.

For conditioning systems in jobs such as office buildings, where cooling towers are used, the best all-round installation uses a comparatively large condenser and somewhat more steam per ton than one where the condenser is available from natural sources. With a large condenser, a moderate size cooling tower can be used. This is important, since the towers are expensive and take up considerable room. It also requires proper provision for the tower support.

Partial Loads

By using several primary ejectors, full load efficiency can be obtained at partial loads and by using primary ejectors of different sizes, full flexibility of operation will be obtained. By using ejectors with capacity ratios such as 1, 2 and 3, operating points may be chosen as follows:

1/6 2/6 3/6 4/6 5/6 and 6/6.

These capacities may be obtained with substantially full load economy at all points of operation.

If desirable, the unit may be so proportioned as to give better economy at lighter loads than at full loads, which is generally desirable in cooling installations.

Typical Units

Fig. 4 shows a 25-ton unit rated at 40°, while Fig. 3 shows its capacity at various chilled water temperatures.

The operation is entirely controlled from the board in the foreground, Fig. 4. The pumps are mounted on the unit, thus eliminating the necessity for foundations for these pumps, and permitting the unit to be lined up, completely assembled in the shop before shipment, so that the unit can be installed as one unit and thus eliminate lining up and piping on the job.

The steam valves, steam gauge, thermostat and push button switches are mounted on the operating board from which the whole unit is operated.

Fig. 5 shows the general arrangement of a 180-ton unit rated at 45°, and Fig. 6 its operating capacity at various chilled water temperatures. This unit is equipped with 30, 60 and 90-ton primary ejectors, one flash chamber and one condenser, so that operating capacities of 30, 60, 90, 120, 150 and 180 tons may be chosen.

Applications and Features

The primary field of application for steam-operated refrigeration units is where chilled water temperatures from 35° to 60° are desired, and where steam is available at reasonable cost, and where condensing water is available from rivers or streams, spray ponds or cooling towers. Where the condensing water is non-corrosive, the repair cost is negligible.

Space requirements are quite moderate. Attention necessary for operation is practically none, consisting merely of seeing that the proper number of primary ejectors are in operation to take care of the prevailing load. Operation is practically noiseless.

The foundations necessary need only be strong enough to support the dead weight, as there are no moving parts requiring accurate alignment.

Additional features are the low first cost and the fact that only low-pressure piping is used, contrasting with the high-pressure piping used on other systems.

Engineering Calculations and Costs of Operation

By J. F. KOOISTRA†

THE steam ejector refrigerating machine consists of a flash type evaporator, steam ejector compressor, condenser, purge or air pump, and a water pump. The water to be cooled is piped into a chamber (the evaporator) in which a high vacuum is maintained. If the water delivered to this chamber is warm and the vacuum is high, the low pressure will cause the water to boil and thus evaporation of a portion of the water will occur. The vapor liberated from the body of water absorbs latent heat of vaporization. This latent heat

†Carrier Engineering Corporation of California, Los Angeles, Calif.

is received from the heat of the liquid introduced into the flash chamber. The abstraction of this heat cools the remaining water to a temperature which corresponds to the absolute pressure in the flash chamber. The water thus becomes its own refrigerant and no other refrigerating medium is required.

This principle of flash evaporation may be easily understood from the following example:

Assume that 1 lb. of water enters the chamber at 55°. Absolute pressure in the chamber is maintained at 0.3 in. mercury. A fraction of the water, X, is vaporized. Latent heat of vaporization at 0.3 in. absolute is 1066 B.t.u. per lb. Heat absorbed, therefore, equals X × 1066 B.t.u. At 0.3 in. absolute pressure the corresponding temperature is 45°, which will be the temperature of the water in the flash chamber. Therefore, the heat given up by the water (specific heat equals 1) is (55-45) × 1 B.t.u. per lb. entering the chamber. From the two equations we find:

$$X \times 1066 = (55\text{-}45) \times 1, \text{ or } X = 0.0094$$

We see that only approximately 1% of the water introduced flashes into vapor, and thereby cools the remaining water 10° to a final temperature of 45°.

It will be necessary to remove the water vapor as fast as it is formed. The specific volume at 0.3 in. absolute pressure equals 2000 cu. ft. For each pound of water we have to remove 0.0094 × 2000 cu. ft. of water vapor. Nineteen cubic feet of vapor per pound of water have to be drawn away to maintain 0.3 in. absolute pressure and 0.99 lb. of water remains in liquid state to be used for cooling purposes.

The evaporation and high vacuum are maintained by the steam ejector compressor. Here we utilize the velocity developed by dropping the entering steam pressure to the evaporator pressure through nozzles. The velocity entrains the vapor from the evaporator and by conversion from velocity pressure to static pressure in the diffuser compresses the entire vapor mass to the pressure in the condenser. The condenser pressure is governed by the temperature of the condenser water available, usually about 28 in. of vacuum or 2 in. mercury absolute pressure. It would be impossible to discharge the steam directly to the atmosphere, which would mean working against a condenser pressure of about 30 in. and a condenser temperature of approximately 212°. If we try to compress the vapor from 0.3 in. mercury to 30 in., it would require a compression rate of 100, which is thermodynamically unsound. Compressing from 0.3 in. evaporator pressure to 2 in. condenser pressure equals a ratio of 7, and the condensing temperature is approximately 100° against 212°.

Fig. 7 shows a section of the steam ejector compressor. It is a simple steam nozzle inserted in a cone. The nozzle regulates the flow of, and expands the steam, to attain high velocity, and in turn this velocity is converted to static pressure in the diffuser. The design of the nozzles is similar to those used in steam turbines. It will be necessary to design a nozzle for every steam pressure and steam characteristic, and chilled temperature required, as will be seen from the following explanation:

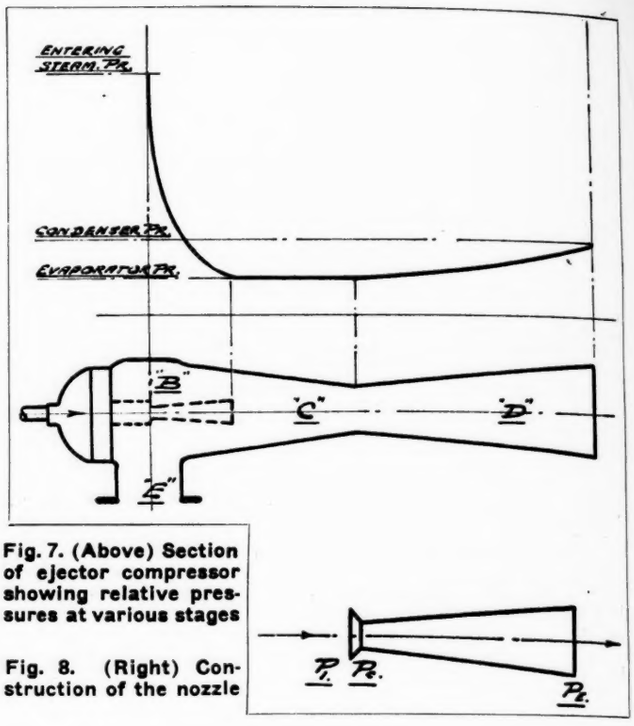


Fig. 7. (Above) Section of ejector compressor showing relative pressures at various stages

Fig. 8. (Right) Construction of the nozzle

Let us assume:

Steam available — 100 lb. gauge pressure
Cold water required — 45°
Capacity required — 82 gal. with a 10° rise

The water vapor to be removed amounts to approximately 1% × 82 × 8 1/3 = 7 lb., or 7 × 19 (from foregoing figures) = 133 c.f.m. The actual amount of steam required to remove this amount of vapor is as determined by tests, 1000 to 1200 lb. per hr., depending on the condenser temperature.

We can now determine the orifice in the steam line required to pass this amount of power steam from:

$$\text{Area} = \frac{W \times 144 \times S}{V}$$

Where

W = weight of steam in pounds per second
S = specific volume at orifice conditions
V = velocity of the steam in the orifice in feet per second
A = cross-section of the orifice in square inches

To find the velocity and the specific volume of the steam, we first have to consider the following:

We know that when steam flows from a higher level to a lower level through an orifice there exists a fixed pressure at the orifice. This pressure is called the critical pressure and is constant. For saturated steam

$P_c = 0.58\ P_i$ where
P_i = entering steam pressure
P_c = critical pressure, or throat pressure

For superheated steam $P_c = 0.55\ P_1$ depending on the exponent of adiabatic expansion. For any condition P_c may be calculated from:

$$P_c = P_i \times \left| \left(\frac{2}{n+1} \right)^{\frac{n}{n-1}} \right|$$

where **n = the exponent of adiabatic expansion**

n for saturated steam = 1.05
n for superheated steam = 1.3
n for isothermic expansion = 1.0

In other words, if the initial steam pressure is 100 lb., the critical pressure will be 0.58 × 100 or 58 lb., and the maximum flow of steam has been reached. To lower the pressure below this point would not increase the amount of steam flow through the orifice.

The steam expands adiabatically from 100 to 58 lb., transforming the available heat (Hp_1–Hp_e) to kinetic energy. Theoretically for saturated steam

$$\text{Vel. in ft. per sec.} = 223.7 \sqrt{Hp_1 - Hp_e}$$

where H = total heat of the steam.

Friction losses lower this velocity about 8% to 15%. In our example, Hp at 100-lb. pressure = 1190.7 and Hp_e at 58-lb. pressure = 1182.7 with a specific volume of 6.00 cu. ft. per lb. 1190.7 — 1182.7 = 8, and the velocity in feet per second is $\sqrt{8} \times 223.7 = 633$ ft. Deducting 10% for losses V = 575 ft. per sec. Then:

$$A = \frac{1200 \times 144 \times 6}{3600 \times 575} = 0.5 \text{ in.}$$

We can expand the steam from its critical pressure to the required evaporator pressure by calculating the various volumes and nozzle areas for intermediate points between 58-lb. pressure and 0.3 in. mercury absolute pressure and obtain a construction as shown in Fig. 8.

It is evident from the above example that for varying steam pressures we will find different critical pressures and corresponding different throat sizes. It is also evident that with varying cold water temperatures and corresponding evaporator pressures the amount of water flashed into vapor will vary, which determines in turn the quantity of steam required.

From the foregoing we note the advisability of installing a pressure regulating valve in the steam supply line to maintain a constant steam pressure at the nozzle. This is necessary for efficient operation.

After the steam and water vapors have been compressed in the diffuser to the condensing pressure, this mass of vapor enters the condensing chamber which consists of a shell with tube bundles, through which the condenser water flows. With 2 in. mercury absolute pressure, the corresponding condensing temperature is about 103° for saturated steam.

The condenser size is based on the amount of heat to be removed, which consists primarily of the heat in the steam, plus 200 B.t.u. per ton of refrigeration. In mechanical refrigeration having NH_3 or CO_2 as refrigerants, we remove approximately 250 B.t.u. per min. per ton, allowing 50 B.t.u. per ton for the heat of the motor, based on using approximately 1.2 hp. per ton for power.

The illustration on this month's cover is presented through the courtesy of The Linde Air Products Company

In our previous example the capacity was 82 gal. of cold water with a 10° rise, or

$$\frac{82 \times 8\ 1/3 \times 10°}{200}$$

= 34 tons refrigeration. The steam consumption is 1200 lb. or 36 lb. per ton, and we have to condense $\frac{36}{60}$ = 0.6 lb. of steam per minute per ton at 103° condensing temperature. Latent heat of vaporization to be removed = 1136 × 0.6 or 682 B.t.u. Adding to this 200 B.t.u. per ton for refrigeration, makes a total of 882 B.t.u. per minute per ton to be removed.

With city water as the condensing medium entering at 70° and leaving at 98° we will require

$$\frac{882}{8\ 1/3 \times 28}$$

= 3.8 gal. of condensing water per minute per ton, or 130 g.p.m. for 34 tons.

In mechanical refrigeration, the power consumption averages approximately 1.2 hp. per ton delivered, depending on the refrigerant characteristics, mechanical design and duty.

In the steam ejector water cooler, steam is the power medium and the consumption is approximately 36 lb. per hr. per ton. With steam pressures other than 100 lb., this steam consumption varies slightly.

Assuming the consumption as 36 lb. per hr. per ton, and the condensing water at 3.8 g.p.m. per ton, the cost of operation, based on 40 cents per 1000 lb. of steam, and water at 13 cents per 1000 gal., would be:

$\frac{36}{1000} \times \$0.40 =$ \$0.0144

$\frac{3.8 \times 60}{1000} \times \$0.13 =$ \$0.0296

Total cost = \$0.0440 per ton per hr.

For mechanical refrigeration, based on 2½ cents per kw.-hr., the operating cost would be:

$\frac{1.2}{1.32} \times \$0.025 =$ \$0.0227

$\frac{2 \times 60}{1000} \times \$0.13 =$ \$0.0156

Total cost = \$0.0383 per ton per hr.

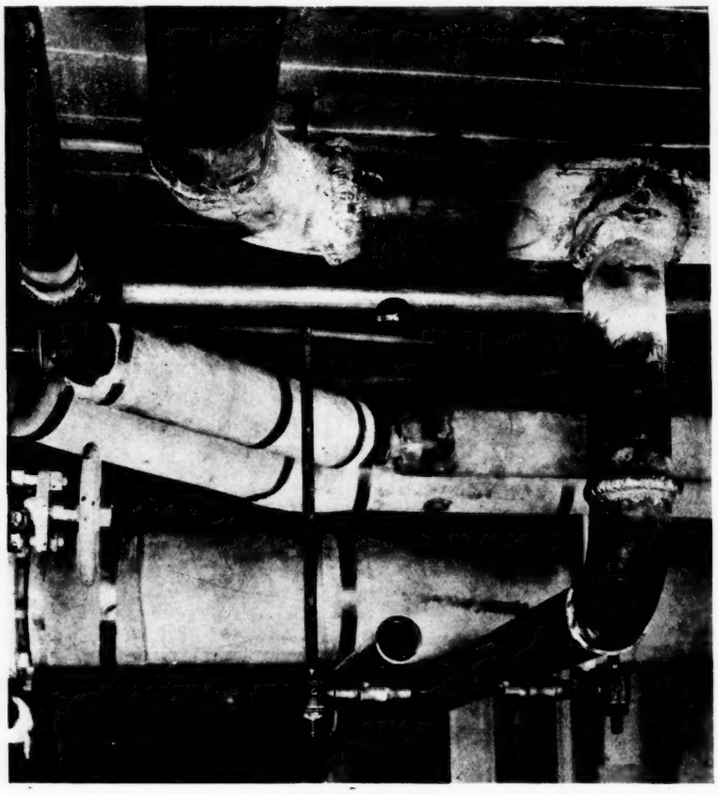
These figures show a slight increase in operating cost between the steam machine and present-day mechanical refrigeration. Manufacturers of this equipment are making extensive tests to increase the efficiencies of the steam nozzles and thereby to lower the steam requirements.

The above calculations are approximate. The writer has tried only to give a general description of this still new equipment, which he believes will have excellent application for air conditioning in medium-size installations.

Recent Developments in Welding Building Piping

New Equipment – Machine Cutting – Present Fabricating Practice – Brass and Copper Pipe – Welding Fittings – Small Pipe Welding – Welder Training

By S. C. CLARK†



Brass hot-water piping with short-radius brass turns and bronze-welded joints. Note preparation of the short-bell type joints not yet welded. The largest line is 4 in.

IN the installation of piping in buildings, the last few years have been characterized by an ever-increasing use of welding in fabrication and erection, especially for heating and refrigeration piping. This is indicated nowhere so clearly as in an article in a recent issue[1] of HEATING AND VENTILATING giving the results of a survey of about 100 important building projects—public and private—specifications for which were released between September, 1931 and October, 1932. On over 50% of the jobs, it was definitely learned that welding was employed to a considerable extent in the erection of the steam piping, and although welding was optional on a large per cent of the total, there were practically no instances where welding was not mentioned in the specifications in a manner to permit its use.

In view of this wide acceptance of welding on the part of contractors, engineers, and architects, and because of the natural interest in the evolution of a new joining method having such universal application, a survey of developments over the past year or more and the present status of many of the aspects of welded piping should prove interesting.

Improved Equipment Facilitates Pipe Welding

With regard to the equipment used on a welded job for fabrication and erection, several devices have been made available which are of assistance on heavy work especially. These are clamps and jigs for holding joints in alignment for tack-welding prior to welding, and self-ejecting dollies on which pipe can be turned during welding. These dollies, or rollers, make the use of a clamp unnecessary if the dolly is placed at the joint,

†The Linde Air Products Company, New York.

[1] "Pipe Welding Developments Affect Engineers and Contractors," December, 1932, page 13.

Welding on short radius turn before putting length of pipe in place

and the self-ejecting feature makes it unnecessary to lift the pipe to remove the dollies. Some contractors prefer to make their own clamps and rollers, but, although this sort of equipment is economically justified in many cases, it is never absolutely essential on any job. In fact, oxy-acetylene apparatus, which is relatively inexpensive, is the only additional equipment needed when a contractor commences the use of welding.

Noteworthy improvements have been made in welding apparatus, particularly welding blowpipes, some of which have been designed especially for pipe welding. Welding heads or tips are light and slender, decreasing fatigue of the operator when welding overhead, and some blowpipe handles are provided with valves in the front so they can be adjusted during welding without using the other hand. The welding blowpipe can be converted for cutting merely by replacing the welding head with a cutting attachment. With some equipment this can be accomplished without returning to the regulators, since approximately the same pressures are used for welding as for cutting standard weight pipe.

Welded Joints Prepared by Machine Cutting

Oxy-acetylene cutting is indispensable on any pipe welding job where fittings are fabricated by welding or where pipe must be cut to length and ends beveled. Such cutting can be readily done with the hand blowpipe. However, there are special machines which have been developed—two of them quite recently—to facilitate making a variety of oxy-acetylene cuts on pipe without the use of templets or marks on the pipe other than center lines to aid in starting the cut and subsequent assembly. Several of the machines, readily handled by two men, are designed for making two bevel cuts simultaneously, such as would be needed when cutting a collar from a line and substituting a welded joint. Single bevel cuts can be made if desired, and with one of the machines cuts can be made around the pipe with the end square or with any bevel desired up to 45°. Heavier machines in use will make single square or bevel cuts for line joints, and in addition properly beveled cuts for tee welds on both main and branch, for angle welds on pipe, and for blunt type bull plugs. By this means, practically every joint required in a welded system can be prepared by oxy-acetylene machine cutting.

One of the larger machines, sufficiently portable to be taken from job to job, was employed on a $6 million project recently completed in San Francisco. Four-piece 90° turns, tees, and bull plugs for the steam piping system were readily prepared for welding in a temporary field shop. Cutting in the preparation of reducers only was done with the hand blowpipe. About two-thirds of the welding was completed prior to erection, thus reducing position welds to a minimum.

A much heavier machine for this same work, intended primarily for permanent shop installation, has been in use for several years. One was employed in fabricating the steam piping for the first contract in a large public building under construction in Chicago. Contractors not wishing to invest in such machines can have cutting done by supply companies who make a business of this work. However, the use of manufactured fittings such as the short radius turn designed for welding may frequently prove more convenient.

Fabrication and Erection Practices

In the actual fabrication and erection of welded piping, there is no single method of procedure in universal favor, probably because of variation in the types of fittings used and of the amount of welding done. It is almost universal practice, however, to weld joints such as tees and fabricated specials while in an accessible position, before mains or headers are put in place. Some contractors prefer to make all welds possible before erecting the piping, either in a field shop or near the final location of the piping, reducing tie-in position welds to a minimum. Others prefer to erect all the piping at once, making only such welds beforehand as would be difficult of execution in place.

New Welding Method Promises Economies

An outstanding development in the field of pipe welding was a new method of oxy-acetylene welding introduced by the writer's company, used to date in the construction of over 3,000 miles of oil and gas pipe lines ranging in diameter from 4 in. to 26 in. The chief advantage of the new method is a considerable reduction in the time and materials consumed in welding, often exceeding 50% where welders trained in the new method do the work. There is no change in the apparatus and materials required except that a special welding rod is used. Other differences from the customary method of welding are found in the manipulation of the blowpipe flame and welding rod, and in the

flame adjustment. Although but little application has been made to building piping as yet, the new welding method promises important economies where welders have been trained in the new technique. It will be most readily applied to welds where the pipe can be turned and welding done on top, although with additional experience, welders can obtain proportional economies in position welding.

Brass and Copper Piping Readily Welded

The advantages of welded construction have recently become obtainable in brass and copper piping systems through developments in joint design and welding procedure. Laboratory research has shown that with high strength bronze-welding rod and a short bell type joint, high strength joints can be obtained in pipe made of copper and copper alloys, such as red brass, Alpha brass, and Muntz metal.

The short radius turns designed especially for welding, which are so extensively used in steam piping installations, are also available in brass. The short bell type joint can be applied easily, the end of the straight length being flared in each case to fit over the end of the short radius turn.

This type of joint and fitting was used effectively in an installation made in a large New York hospital center. The entire hot water system is Muntz metal pipe ranging from 1½ in. to 6 in. in diameter and brass short radius turns are used throughout. The design working pressure is 90 lb. per sq. in.

Fittings Available in Variety of Types and Metals

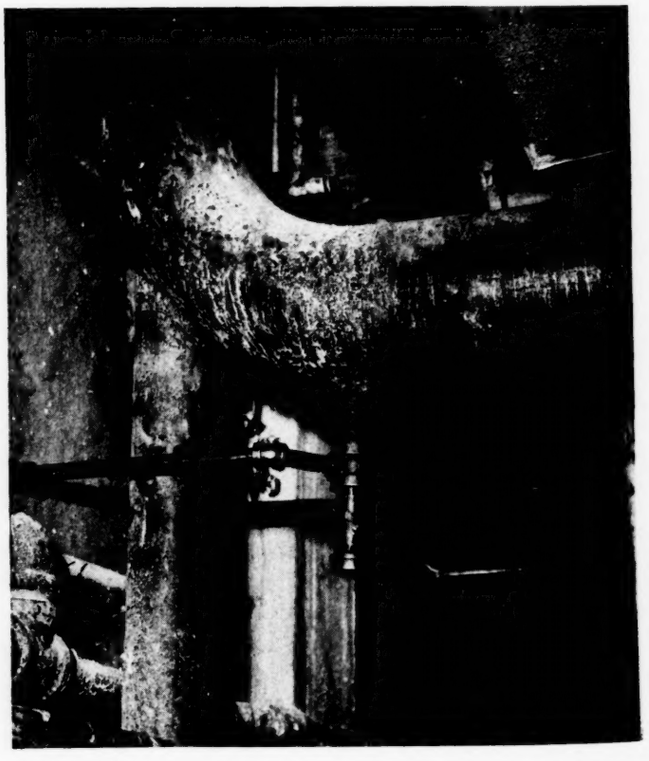
Short radius turns are available in other metals besides steel and brass, wrought iron and special copper-bearing steels being the more common. Several manufacturers are in a position to supply turns made of other weldable metals and alloys on special order. Fittings manufactured specially for welding into piping systems are no new thing, the short radius turn with the wall thickness the same as the standard pipe having been manufactured in this country since 1927. The flange with a high hub for welding directly to pipe appeared even before this. More recently bull plugs, tees, and concentric and eccentric reducers have become available. Valves provided with nipples for welding to pipe can be readily secured in the larger sizes for services requiring steel bodies. Other specials designed to facilitate the making of branch connections are also obtainable. In fact, the interest among the larger fabricators and supply companies is so great that there are now at least 12 who distribute a complete line of fittings for welding.

The fittings mentioned which are welded directly to pipe ends are ideal from the standpoint of design and welded construction, and are almost universally used in high-pressure construction. That they are very popular for low and medium-pressure steam piping—especially the short radius turn and the welding neck flange—is shown by their general acceptance for this class of work. The survey of current welded piping installations in public and private building mentioned at the beginning of this article disclosed that on well over half the jobs where welding was required or optional, short radius turns were specified.

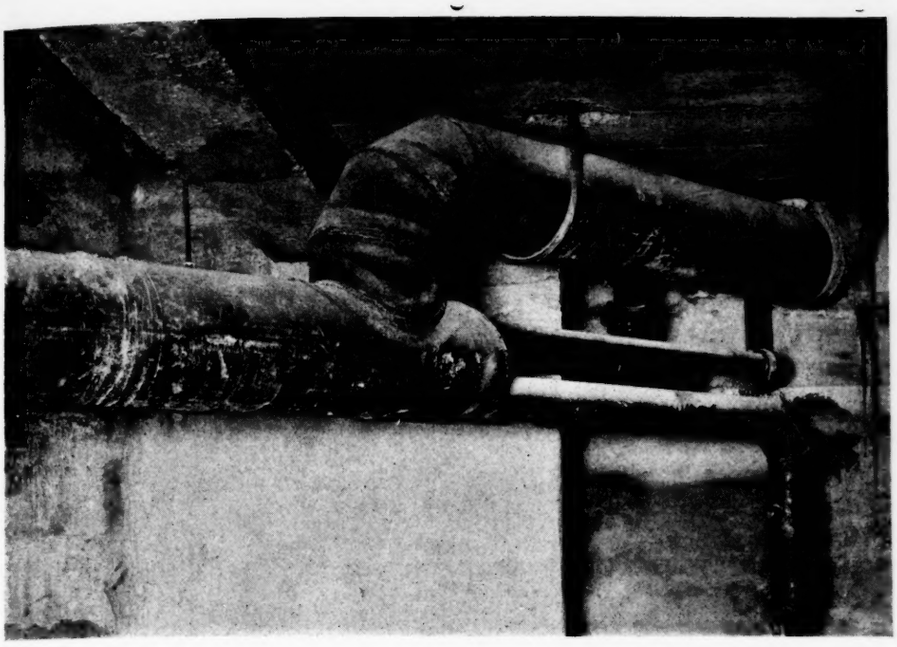
Trend Toward Welding Small Pipe

After the decision has been reached to employ welding on a piping system, the question will usually arise as to what the smallest diameter pipe to be welded should be. While the tendency has been in the direction of the smaller sizes, this does not answer the question, since practices in this matter vary considerably. It might be asked why all sizes should not be welded, and indeed, this is often done with high pressure or process piping where leakage and maintenance as well as the expense of special fittings are the most important factors.

Welding a joint essentially involves replacing with weld metal the pipe metal cut away in forming the vee. Consequently, the cost of a welded joint increases almost directly in proportion as the diameter and wall thickness of the pipe. With fittings, however, the cost increases more rapidly with an increase in pipe size, and still more rapidly with increases in pressure and service requirements. Theoretically, therefore, it should be possible for a contractor to estimate a piping job and determine just how the cost of a welded system compares to that of a fitted job. It should be remembered, however, that there are many savings to the contractor that can be attributed to welding other than the actual difference in cost of labor and material between the welded and fitted joint. There are some contractors specializing in welded construction who prefer to weld all sizes since they then need but one type of equipment



Method of supporting 12 in. riser extending up 20 floors in office building



End of 12 in. main closed with blunt type bull plug. Outlet to riser is through 12 in. welded tee and fabricated 4-piece turn

and workman on the job, making for increased smoothness in the progress of the work. With a majority of welded installations, however, the diameter at which welding is started ranges between 2 in. and 4 in. Local wage rates, experience with welding of the contractor's organization, size of the job, and the desires of the engineer or architect are all factors contributing to the decision as to the sizes welded.

An example of a structure in which practically all sizes of steam piping are welded is a 45-story office building being erected in Chicago. All mains, principal risers, and radiator supply risers—including branch connections in the risers—are welded, taking in pipe as small in diameter as ¾ in.

In the matter of the standardization of welding practices and the training of welders, considerable has been accomplished. The "Standard Manual on Pipe Welding," issued some years ago by the Heating and Piping Contractors National Association, has met a real need among contractors, pipe fitters, architects, and engineers for up-to-date and authoritative information concerning the standards, practices, and theory of pipe welding. It is especially useful to those learning pipe welding. General adherence to standard qualification tests described in this Manual as a part of a model welding specification is having the desired effect of increasing the quality of workmanship on welded piping installations.

Classes for training steamfitters and plumbers in welding —chiefly in evening vocational schools supported in part by Federal aid—are performing splendid service in giving journeymen their basic welding training. Brief apprenticeship under more experienced welders on the job generally enables them to qualify in a relatively short time for the more difficult joints and positions of welding.

A recently completed welded power piping installation in a New Jersey electric generating plant illustrates the use of journeymen steamfitters for important work and the acceptance of oxy-acetylene welding for power plant piping operating at high temperatures and pressures. Local steamfitters were put through exacting tests before being allowed to work on this job, the principal line of which consists of 16-in. seamless pipe with a wall thickness of 1 9/16 in. The operating pressure is 730 lb. per sq. in. and the temperature 860°.

The trend toward the adoption of welding generally for building and industrial piping is unmistakable and has been recognized by the leading contractors in every large building center in the country, who are almost without exception equipped to handle welded jobs. Many of those who first employed welding and cutting for emergency or occasional repair work are now among the most active supporters of welding for all its applications in the piping field.

Main Supplying steam for heater. Note welded turns and blunt type bull plug

Welding Cracked Boiler Sections†

RECENT investigations have opened what promises to be a profitable field of repair and reclamation work for contract welding shops and heating contractors through the oxy-acetylene bronze-welding of cracked low-pressure cast-iron boiler sections used for heating purposes. The repair of cast iron by means of bronze-welding is being used almost universally for practically all types of gray iron equipment, but until quite recently it has not generally been the practice to apply this process to boiler-section repairs. Careful study of this application has shown that by following a certain definite procedure successful results will be assured the welding or heating contractor in this work.

Because of the usual complicated shape of these hollow castings, with thin walls adjoining heavier sections of quite unequal thickness, more than the usual care must be applied to prevent overheating of local areas while bronze-welding.

Another factor to be considered is that most cracks in boiler sections do not extend to an opening in the casting. Due to the limited elongation characteristics of cast iron it is absolutely essential that the expansion and contraction resulting from the welding operation be carefully controlled.

Boiler sections present unusual conditions such as welding on large flat surfaces of thin cast-iron sections where the greatest of precaution is necessary if the work is to be closed satisfactorily. In some cases total preheating of the casting will be essential.

Another condition not generally found in the ordinary gray iron casting, but of primary importance when considering a repair to a boiler section by means of bronze-welding is that, due to the continual exposure of the sections to fire and heat when in use, a change takes place in the surface of the metal itself.

Because of the fact that oxy-acetylene repair work on boiler sections necessitates special consideration for the reason just outlined, such work should be undertaken only after the welding operator has made a careful preliminary study of the conditions to be encountered and supplemented this study with practice.

The method generally recommended is to obtain a scrap cast-iron boiler section and make several test welds on it before attempting to make bronze-welded joints on a section that is to be placed in service again. The metal around these practice welds can then be broken out with a hammer and examined to see whether proper bond and soundness of weld metal have been obtained. In this way the welder can experiment with tip sizes, amount of flux, methods of chipping or grinding, metal temperatures, and other variable conditions.

In considering the repair of a boiler section, a correct determination of the size, position, and extent of the crack is the first requirement, as this will indicate whether or not the section can be repaired in place without dismantling.

If the crack is accessible from the exterior of the boiler, or from any comfortable welding position inside, it may be possible to bronze-weld in place. Long, extended cracks, or those extending to an inaccessible part will mean that the boiler has to be dismantled and the section removed before welding it. On the other hand when the crack is short and confined to some flat or convex surface facing the furnace interior, it is the ideal condition for position bronze-welding and no dismantling should be necessary.

The crack to be welded should first be completely located as to branches and extent. If there is any uncertainty, this can most easily be determined by cleaning off the scale and rubbing oil over the surface of the cast iron at the ends of the crack or branches and then wiping off all excess oil with a piece of cloth or waste. Then by rubbing white chalk over all oiled surfaces adjacent to the crack, the oil will be absorbed by the chalk, causing an outline of the crack to appear.

When the extent of the crack or cracks has thus been found it is usually a good idea to drill a small hole, at least ¼ in. diameter, through the cast iron just beyond each end of the crack. This will tend to prevent the crack from extending further when the heat of the blowpipe is applied.

If it is then considered advisable to dismantle the boiler, the section should be removed, cleaned, and laid in a flat or slightly inclined position where the crack will be most accessible. The repair can be most easily made if the casting is placed in such a position that the bronze rod can be applied on a nearly level surface. With some types of cracks it probably will be found desirable to incline the section so that the welding will travel slightly up grade. On the other hand, it will also be found that for position welding the new high strength bronze welding rod is ideal and can be easily applied in all positions.

Next the crack should be ground or chipped down to clean metal, whether the welding is to be carried out

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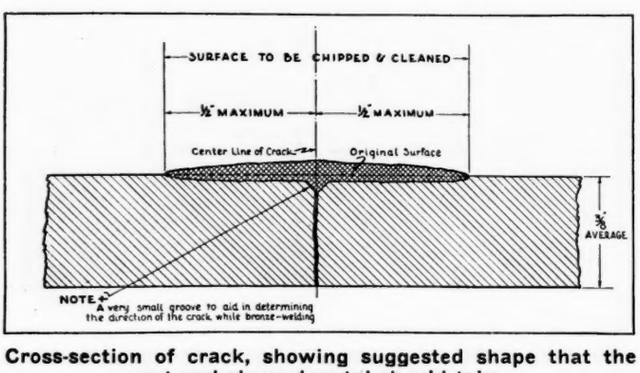
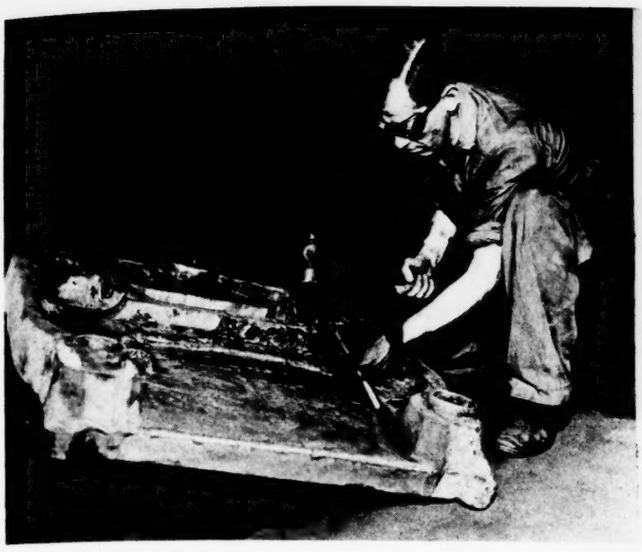
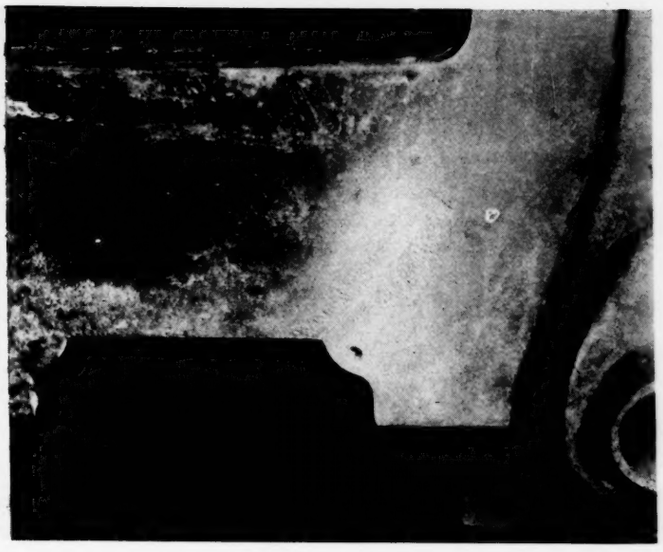

SURFACE TO BE CHIPPED & CLEANED
½" MAXIMUM
½" MAXIMUM
Center Line of Crack
Original Surface
⅜" AVERAGE
NOTE—A very small groove to aid in determining the direction of the crack while bronze-welding

Cross-section of crack, showing suggested shape that the cut and cleaned metal should take



1. It is essential that the casting be cleaned and chipped to clean metal

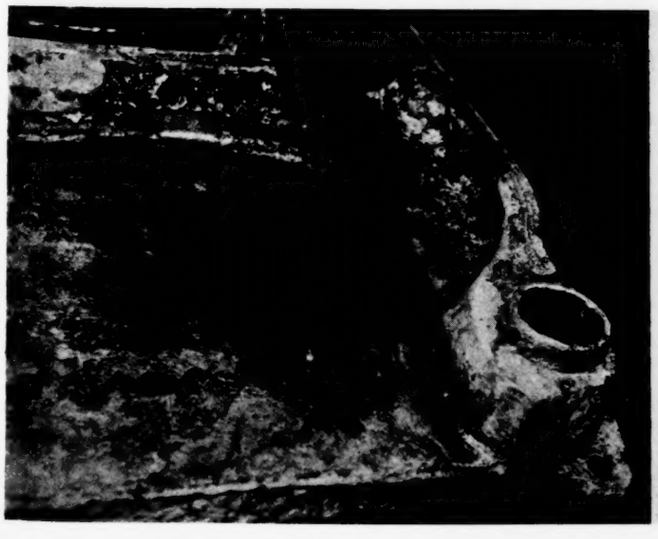


2. A typical crack, cleaned and chipped, ready for the blowpipe

5. The finished section, successfully welded

3. The crack is now ready to be bronze-welded

4. Repairing the cracked section with bronze welding rod



in position or the boiler dismantled. If chipped, the usual groove or vee that is formed for welding purposes should be avoided and instead the surface on each side of the crack should merely be cleaned by removal of a light chip sloping toward the crack so that only a shallow deposit of bronze will then be necessary. Then a very light groove can be chipped only to aid in following the crack while welding. A thin layer of the bronze weld metal will stretch readily during the cooling and contraction, whereas a thicker layer would not, thus causing either further cracking of the casting or causing the heavy bronze layer to pull loose a section of the cast iron adjacent to the crack.

For chipping, a chisel is recommended which should be sharp enough so that a wide, very shallow cut can be easily made down to clean metal. Great care should be taken to continue the chipping as far as the crack extends. A portable electric grinder is also convenient for performing this work. In addition, the metal on each side of the cut should be thoroughly cleaned with a wire brush or by light grinding to remove all grease or other dirt from the vicinity of the weld. Clean metal, then, including the cut, should extend to at least ½ in. on either side of the crack. The accompanying cross-section diagram shows the suggested shape that the cut and cleaned metal should take.

The usual equipment for carrying out oxy-acetylene repairs of all types is used for repairing cracks in boiler sections. For this work, however, the blowpipe head or tip should be about two sizes smaller than would ordinarily be used. For instance, if the thickness of metal were such that ordinarily a No. 5 tip would be used, for this application select a No. 3 tip. By doing this better control of the heat from the flame can be secured and as the use of the least possible amount of heat is essential this control is vital to a successful job.

Good "tinning" of the bronze is most important. When molten bronze is applied to a clean, fluxed surface heated to the proper temperature (a dull red heat) a thin layer of bronze will flow and spread out over the metal a little ahead of the main deposit. The flow will be free and natural like water spreading over a clean, damp surface, and will not have the appearance of water spreading on a greasy surface. The edge of the molten bronze will not round out like a drop of mercury, but will tend to spread out and flow freely over the heated metal.

A trial application of fluxed bronze rod will immediately indicate whether the cast iron will "tin" easily or not. If it will not, when the correct temperature is used, prefluxing is necessary. This can be done by dusting or spreading a strong oxidizing agent such as powdered potassium chlorate on the part of the cut heated to a red color just ahead of the weld puddle. This material can be spread around, and as soon as the effervescence or foaming due to the heat ceases, the regular tinning and bronze-welding will proceed easily and rapidly. This oxidizing of the cast-iron surface leaves a normal gray iron surface to work on.

It is advisable to start the bronze-welding just beyond the visible limits of the crack or break, because often the fracture extends further along on the inner surface of the metal than can be seen from the outer surface. If the break extends into irregular sections of the casting or to edges or corners, the welding should move toward that point. In other cases the progress of the weld should be from the ends of the crack toward the middle and should also progress from the outer ends of any small branch cracks toward a central point.

Care should be taken to control the heat applied in welding a cast-iron boiler section, so that it will not become too hot. Unless the casting is preheated the welding operation should be limited to very short applications of the welding flame, welding about ½ in. or 1 in. of the crack at one time. After each application of heat, sufficient time should be allowed so that the section cools down before welding is resumed. This will tend to minimize the expansion of the casting and the consequent shrinkage stresses.

Introduce the end of the bronze welding rod into the flame while the first portion of the crack is being brought to bronze-welding heat and then dip it into the brazing flux for an instant. Sufficient flux will stick to the heated rod. Then apply the rod to the heated spot. If the cast iron is at the proper temperature, first the flux will flow out and cover the surface of the iron and immediately the bronze will flow onto the iron to produce the "tinning" coat.

Hold the rod in the flame approximately in line with the joint. Hold the blowpipe in such a manner that the flame after striking the weld reflects so that it preheats the joint ahead of the molten puddle.

Gradually move the puddle forward; use the swinging motion of the blowpipe and rod characteristic of all ripple welding, the motion of the blowpipe and rod being opposite to each other. Keep the inner cone of the flame about ⅛ or ¼ in. away from the surface of the puddle. Flux should be applied frequently and in sufficient quantity so that a layer of molten flux will precede the bronze at all times. Apply the bronze to the cleaned cut surface as the weld progresses so as to extend at the most not more than a ½ in. on each side of the crack; this will avoid delay in going back to touch up previous work and will also help to keep the temperature of the cast iron as low as possible. The speed of flow of the "tinning" film will govern the speed of welding.

When the crack in the section is of such a character that it is necessary to dismantle the boiler, it will be found that the welding operation is materially simplified by preheating the entire casting. This will eliminate the necessity of applying the bronze in the short stretches recommended for position bronze-welding. For preheating, the casting should be placed in a temporary fire-brick furnace or enclosure and heating by a slow charcoal fire to an even black heat (about 500°). Subsequently when the weld is completed, the casting should be covered with asbestos paper, reheated to an even red heat, and permitted to cool slowly in the furnace until quite cold. Care should be taken while the section is cooling to prevent any drafts of cool air from striking the casting. The welded boiler section should then be tested hydrostatically at the pressure developed by the ordinary water supply.

ESTIMATING DUCTWORK

Weights of Rectangular Galvanized Steel Ducts per Foot—1" x 21" to 20" x 40"

1" x 21" to 20" x 40"

WEIGHT OF GALVANIZED IRON DUCT PER LINEAL FOOT

Wt. Lbs. per Sq. Ft.	Gauge	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Sq. Ft. per Lin. Ft.	Gauge	Wt. Lbs. per Sq. Ft.
2.7	16	10.35	10.80	11.25	11.70	12.15	12.60	13.05	13.50	14.18	14.63	15.08	15.53	15.98	16.43	17.33	17.78	18.23	18.68	19.13	16	2.7
2.2	18	8.43	8.80	9.17	9.53	9.90	10.27	10.63	11.00	11.55	11.72	12.28	12.65	13.02	13.38	14.12	14.48	14.85	15.22	15.58	18	2.2
1.7	20	6.52	6.80	7.08	7.37	7.65	7.93	8.22	8.50	8.93	9.21	9.49	9.78	10.06	10.34	10.91	11.19	11.48	11.76	12.04	20	1.7
1.4	22	5.37	5.60	5.83	6.06	6.30	6.53	6.76	7.00	7.35	7.57	7.82	8.05	8.29	8.52	8.75	8.99	9.22	9.45	9.67	22	1.4
1.2	24	4.60	4.80	5.00	5.20	5.40	5.60	5.80	6.00	6.30	6.50	6.70	6.90	7.10	7.30	7.70	7.90	7.70	8.10	8.30	24	1.2
0.9	26	3.47	3.63	3.78	3.93	4.08	4.23	4.38	4.53	4.76	4.91	5.06	5.21	5.37	5.51	5.82	5.96	6.12	6.27	6.42	26	0.9
Sq. Ft. per Lin. Ft.		3.67	3.83	4.00	4.17	4.33	4.50	4.67	4.83	5.00	5.17	5.33	5.50	5.67	5.83	6.00	6.17	6.33	6.50	6.67	6.83	Sq. Ft. per Lin. Ft.		

CROSS-SECTIONAL DIMENSIONS OF DUCT-INCHES

Sq. Ft. per Lin. Ft.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Sq. Ft. per Lin. Ft.
7.00	7.17	7.33	7.50	7.67	7.83	8.00	8.17	8.33	8.50	8.67	8.83	9.00	9.17	9.33	9.50	9.67	9.83	10.00						
6.57	6.73	6.87	7.10	7.25	7.41	7.55	7.70	7.96	8.00	8.15	8.31	8.46	8.61	8.76	8.91	9.05	9.20	9.44				26	26	0.9
8.70	8.90	9.10	9.40	9.60	9.80	10.00	10.20	10.40	10.60	10.80	11.00	11.20	11.40	11.60	11.80	12.00	12.20	12.50				24	24	1.2
10.15	10.40	10.62	10.97	11.20	11.43	11.67	11.90	12.13	12.37	12.60	12.84	13.08	13.30	13.53	13.77	14.00	14.23	14.60				22	22	1.4
12.33	12.61	12.89	13.32	13.60	13.88	14.17	14.45	14.73	15.02	15.30	15.58	15.87	16.15	16.43	16.72	17.00	17.28	17.71				20	20	1.7
15.95	16.32	16.68	17.23	17.60	17.98	18.33	18.70	19.07	19.43	19.80	20.17	20.53	20.90	21.27	21.63	22.00	22.37	22.92				18	18	2.2
19.58	20.03	20.48	21.15	21.60	22.05	22.50	22.95	23.40	23.85	24.30	24.75	25.20	25.65	26.10	26.55	27.00	27.45	28.13				16	16	2.7
Sq. Ft. per Lin. Ft.																						Sq. Ft. per Lin. Ft.	Gauge	Wt. Lbs. per Sq. Ft.

CROSS-SECTIONAL DIMENSIONS OF DUCT-INCHES

WEIGHT OF GALVANIZED IRON DUCT PER LINEAL FOOT

Published by Heating and Ventilating, 148 Lafayette St., New York.

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H. & V.'s REFERENCE DATA—3

ESTIMATING DUCTWORK

Weights of Rectangular Galvanized Steel Ducts per Foot—1" x 41" to 20" x 60"

1" x 41" to 20" x 60"

WEIGHT OF GALVANIZED IRON DUCT PER LINEAL FOOT

| Wt./Sq.Ft. | Gauge | | |

Modernizing Steam Heating Systems with Pumps

By JOHN A. MASEK

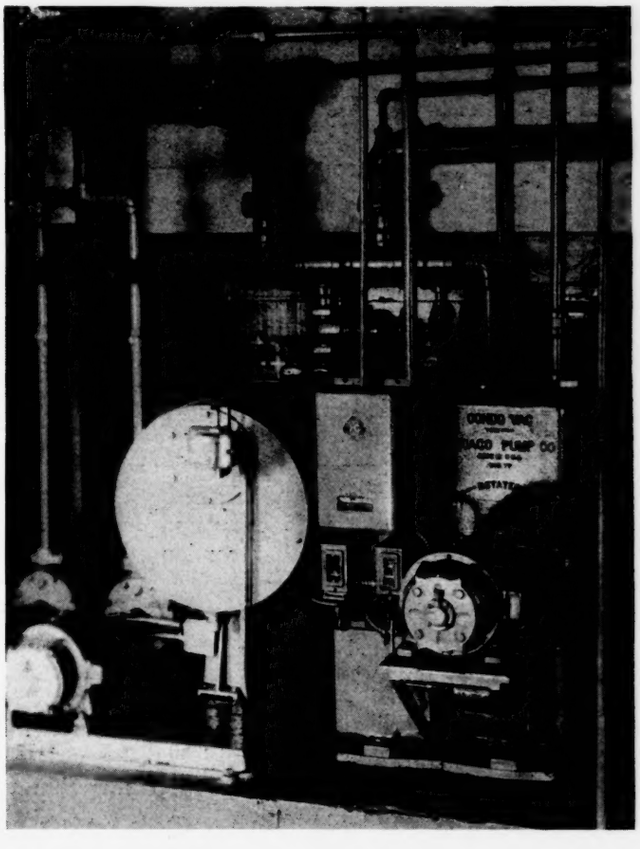
DURING recent years many buildings have been planned and executed in haste without due consideration for operating economy and efficiency. In most cases first cost has been the deciding factor in the specification of equipment. Price cutting, unethical tactics, and the practice of forcing bonds in lieu of cash payment have all too often seriously hampered the design and installation of proper and adequate heating systems.

A favorite practice in the game of cutting off equipment has been to eliminate pumps—both vacuum and condensate. As a result we now have comparatively new plants originally intended for use with pumping equipment, but completed without any. Moreover, many plants which fail to operate satisfactorily can be cured of circulation troubles by installing a pump. Knowing that both these conditions exist, I thought it would be interesting to look into the actual experiences which have followed some of these cases. They were not hard to find, and the following are some interesting instances gleaned in the Chicago vicinity only.

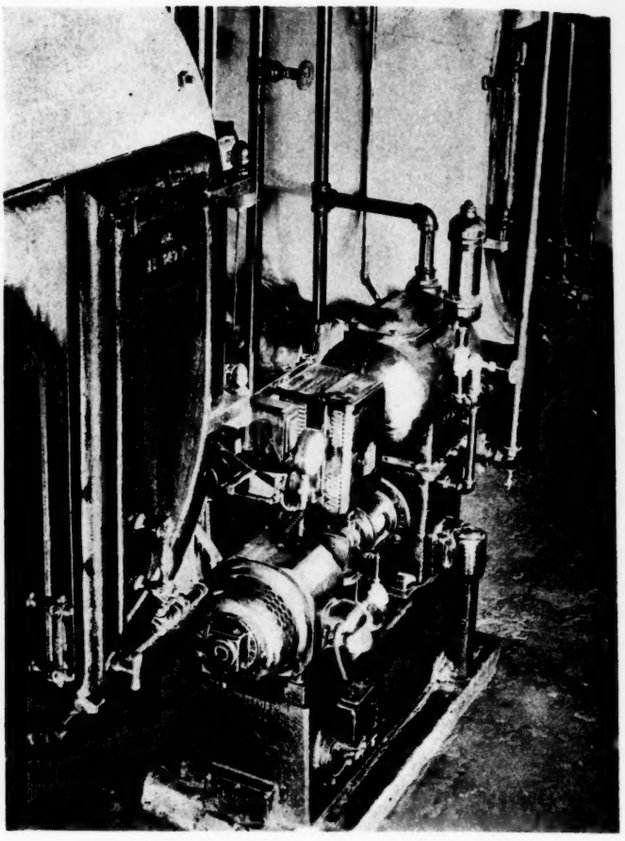
As case one, consider the heating system of a twenty-one story hotel (Fig. 1), built four years ago, and designed as a two-pipe overhead vapor installation. Two oil-fired steel boilers supplied steam to the system which contained approximately 26,000 sq. ft. of radiation. A vent trap in the basement relieved the air, and since the water line of the boiler was higher than the vent trap, a condensation pump was installed to discharge the condensate back to the boiler (Fig. 2).

In order to get steam down to the first six floors it was necessary to carry a minimum pressure of from 5 lb. to 10 lb. at the boiler most of the time. A comparison of figures showed that fuel consumption was higher for the hotel than for larger buildings previously operated by the management. A change in operating engineers failed to bring about improvement in economy or performance. The oil burners were replaced by coal stokers, and still no great reduction in operating costs or working pressure resulted.

Again the operating engineer was replaced, and this man, more progressive than the others, immediately insisted upon the installation of a vacuum pump in place of the condensation pump. Outside opinion readily confirmed the advisability of the change-over to a vacuum system, and a new pump was installed at a cost of approximately $600. The other pump was left



Figs. 1 and 2. In spite of the beautiful interior layout of the hotel above, operation was unsatisfactory, for the first six floors could not be heated and the fuel costs were high. The vacuum pump was finally installed so that the entire building was heated with a steam pressure of less than ½ lb.



Figs. 3 and 4. Complaints of tenants over failure to secure heat were responsible for the installation of the vacuum pump in the above building. The pump replaced the old condensation pump, and complaints immediately stopped.

in place and by-passed, to serve in case of emergency.

When the plant was put into operation, the radiators on the lower floor heated satisfactorily with ½ lb. pressure on the boiler, and in addition no overheating of the upper floors was experienced. Even distribution of steam has proved to be possible at this pressure in the most extreme weather, and the system regularly functions satisfactorily with but a few ounces of steam, conditions impossible of attainment previously.

Since there is little coal storage space in the basement, coal deliveries are made daily at a cost of between $30 and $40 per day. Since the vacuum pump has been in service a definite saving of at least $5 per day has been noted, and it is indicated that the pump will pay for itself in the course of a few seasons. Had the pump been included in the original installation, much inconvenience would have been prevented, tenant dissatisfaction would have been avoided, and the cost of replacing the oil burners would have been saved.

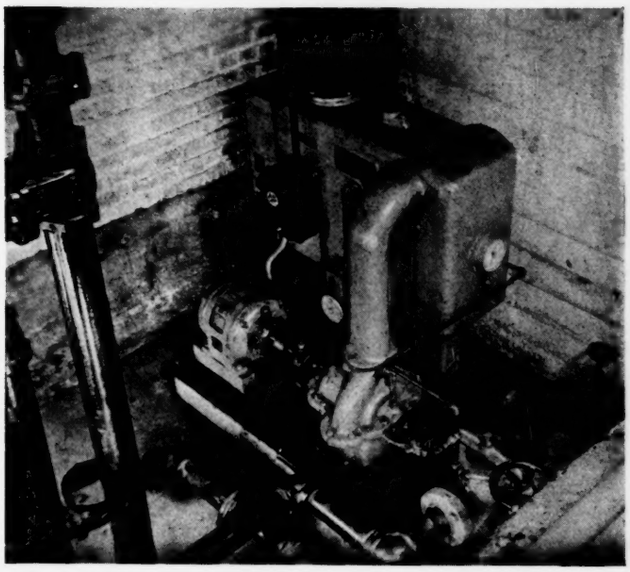
Another case is that of a 15-story apartment hotel (Fig. 3). When it was erected, a condensation pump was installed on assurance that the results would be satisfactory. The piping was laid out partly downfeed and partly upfeed. During the first winter of operation, a number of tenant complaints reporting a lack of heat in several portions of the building came to the management's attention. Steam pressure in the two oil-fired boilers was raised to 5 lb. with little or no improvement resulting. It was obvious that something had to be done to correct the fault.

At this point the manager recalled that in every hotel in which he had previously served, a vacuum pump had been connected into the return. After consultation, a vacuum pump of 40,000 sq. ft. capacity was installed (Fig. 4). The removal of air and condensate within the system induced the steam to circulate in the sections of the building that had given trouble.

During periods when the outside temperature has fallen to zero, a maximum steam pressure of 1 lb. has been found to be sufficient, and in mild weather, pressures ranging from atmospheric to a few ounces supply ample heat to all parts of the building. This was not possible before the pump was installed, and in addition the management reports an estimated fuel saving of at least 10%.

In a six-story factory building (Fig. 5), erected about eight years ago, a two-pipe upfeed type of vapor heating system of conventional design was installed. The building contains a total of 1,038,870 cu. ft. of space, with 11,888 sq. ft. of direct radiation. Return traps vented the air and returned the condensate by gravity to the two oil-fired cast-iron boilers. During the heating season there was always difficulty in getting steam to the top floor, and circulation was sluggish in this part of the building. After six seasons of discomfort and inconvenience to employees, a vacuum pump was installed to induce circulation in the cold areas (Fig. 6). This pump was of 16,000 sq. ft. capacity, and its operation made it as easy to supply heat to the top floor as to the first floor, and at a greatly reduced pressure. In addition, the morning heating-up periods were reduced from 2 hr. to 45 min.

A comparative fuel record for the last two years against the year previous to the change-over reveals the saving brought about by the vacuum pump. The figures represent the cost of heating the building plus



Figs. 5 and 6. The factory shown above was not heated satisfactorily with the existing vapor system. Installation of the vacuum pump rectified previous difficulties, gave satisfactory heat, and reduced fuel consumption.

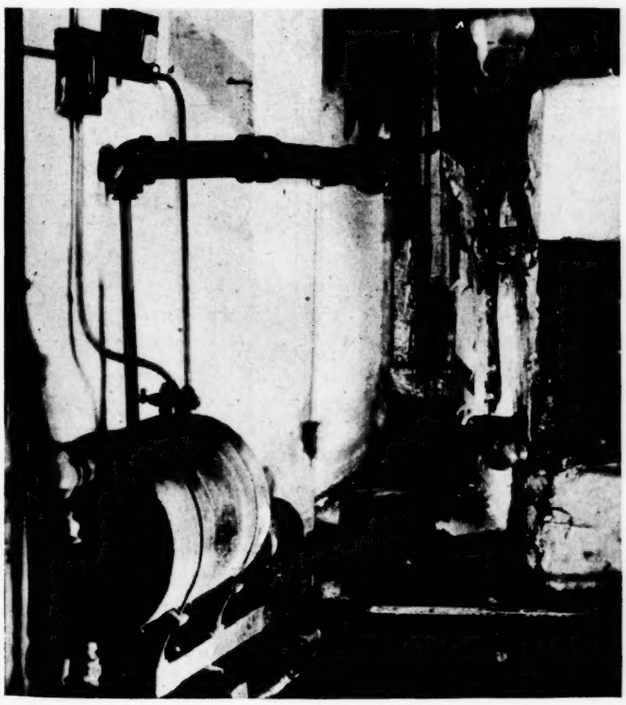
the hot water service, supplied from a 1000-gal. storage tank. Prior to the change-over, the hot water was heated directly with coal.

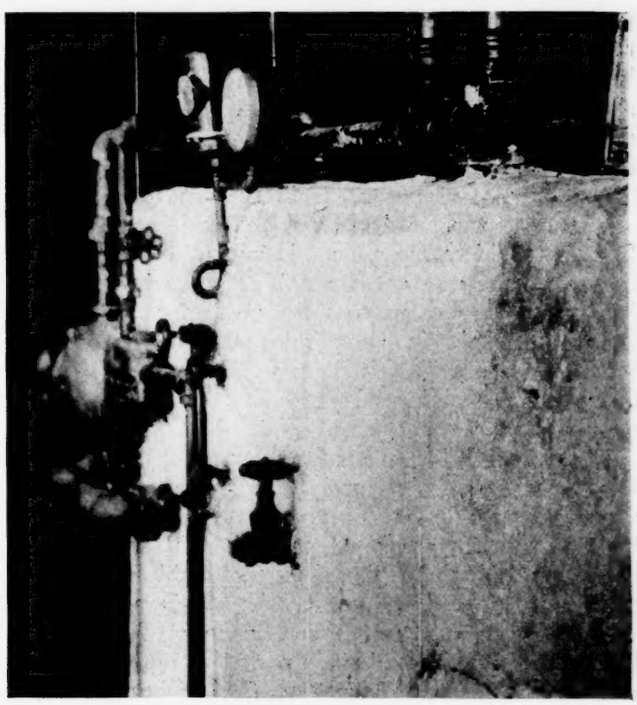
COST OF HEATING A SIX-STORY FACTORY

	1931	1930	1928
February	$374.40	$334.78	$732.78
March	416.46	463.42	550.34
April	234.83	274.98	440.62
May	54.60	124.36	69.94
June	47.90	none	116.39
July	none	57.33	82.15
August	none	none	none
September	45.16	52.11	63.00
October	106.83	203 85	127.31
November	131.40	358.89	408.73
December	460.65	395.24	496.68
January	379.30 (1932)	428.68 (1931)	623.06 (1929)
Total	$2,251.53	$2,693.64	$3,706.04

The lower cost of fuel during the last two years cannot be attributed to the vacuum pump alone, as the heating seasons were milder than those of preceding years, and the price of fuel itself has been reduced. The vacuum pump for this job was purchased and installed at a cost of $900, and a good return is expected on this investment.

A fourth case, and one where a condensation pump was used to cure a sick system, is that of a large two-story warehouse, sales, and office building. This structure was erected about 12 years ago, and was heated by a one-pipe gravity system which was a constant source of trouble. Not only was there insufficient heat in extreme weather, but on three different occasions sections of the cast-iron boiler cracked due to failure





Figs. 7 and 8. Before the condensation pump, shown to the left, was installed, boiler sections were cracked, fuel consumption was high. An automatic water heater, shown to the right, and the pump, solved the problem.

to return condensate, caused by water logging of the return main.

These cracked sections had to be repaired in mid-winter at a cost reported as approximately $700, and it was estimated that the loss incurred through shut-downs, and inconvenience amounted to several times that figure. To prevent a recurrence of this trouble, a condensation pump and a boiler feeder were installed (Fig. 7 and 8). This change has resulted not only in better performance, but in definite fuel saving.

When the original job was installed, a 3-in. return main was specified. This main was more than 200 ft. long. Had the condensation pump been installed at this time, a 2-in. return line would have been ample, and would have reduced the cost of piping by at least $40.

These four cases are typical and the experiences would probably not vary a great deal if additional cases were examined. Lessons drawn from these cases can be generalized. Several points are brought out which are worth considering.

In the first place the general symptoms are the same in all cases. The system does not circulate properly, and raising the boiler pressure is not a cure. The cure must be looked for in the circulation. Sometimes it can be found in the piping, and if so, installation of a pump is not necessary.

Another point is the choice of pump. Both the vacuum and the condensation pump have their place. Blanket recommendation of either one to cure a sick job is certainly not the thing. Instead, find out which kind is called for by the circumstances. Use of either the condensation or vacuum pump can produce fuel savings and satisfactory operation, in cases where piping headroom is small, returns too close to the water line, where piping was installed undersized, or where the piping has become slightly trapped due to the settling or sagging of the pipes.

All of the cases cited bring out the fact that the building owners finally had to pay more than would have been necessary if suitable pumping equipment had been made items of original cost instead of being added after unsatisfactory operation made them imperative —all of which goes to prove that the cutting out of pumps in order to save first cost is a procedure which, while it may help to get past temporary difficulties, may bring on later troubles even more acute than the original ones. Every job does not need a pump, but the use of pumping equipment should be fully and carefully considered.

Be that as it may, the fact remains that many existing buildings with faulty circulation can be helped by putting in the right pump, and it can be made to pay its cost. Now, when new building is slack, a source of new business lies in finding out these jobs where there are complaints. Often a faulty plant is giving so much trouble that even now owners can be shown that the installation of a pump is worth while. Pumping equipment has a place in any revamping or modern'zation project.

Training Journeymen in Welding

AT present, employers and mechanics, as well as manufacturers, frequently object to the promotion of training programs in welding on the ground that this is not the time to promote in an aggressive manner such programs for our mechanics. This viewpoint is thoroughly unsound from the standpoint of our immediate needs for skilled mechanics as well as from the standpoint of our needs in the immediate future.

Such a shortsighted viewpoint considers neither the fact that welders are not made overnight nor the fact that while the needs may not be great today we have justification to believe that the needs for trained and skilled mechanics in every industry that uses welding will increase consistently from year to year. The time to begin the training of these mechanics, therefore is today.

In our own industry it takes from three to five years to make a steamfitting mechanic. Our mechanics serve an apprenticeship extending over this period during which time they are hired, trained, paid and worked as learners. We have, therefore, the double problem of training to do welding, those who are in a period of apprenticeship and those journeymen mechanics who have already completed their period of apprenticeship and who range in age from 21 to 60, and in some cases even above 60.

The type of mechanic needed in our industry differs from that found in some other lines of work. Our needs require the development of welders from within the ranks of present steamfitters. A plan involving specialized mechanics who would do nothing but welding does not fit into the operating conditions found in our industry and is not economical from the standpoint of labor costs. Welders in our field must not only be artisans from the standpoint of welding, but must have the same initiative and technical ability to design, take measurements, read blue prints, and the like, as is required of the steamfitter. The steamfitter who possesses these qualities can be kept steadily employed, which is an important factor in the development of his welding skill.

The problem of training new recruits is being met in our industry by introducing into the training courses of the apprentices a pipe welding program which becomes a part of the learning process which they go through. The latter problem of the training of journeymen mechanics is a somewhat more difficult one, but is being handled by bringing the journeymen together for evening school instruction, in most cases two hours twice a week for an intensive period of eighteen to thirty-six weeks.—*From an address by Dr. S. Lewis Land, Heating and Piping Contractors National Association, before the 33rd annual convention of the International Acetylene Association.*

Estimating Annual Power and Water Costs for Air Conditioning

By E. P. WELLS†

WHEN a new air conditioning system is being planned the problem of estimating the annual operating cost frequently arises. Two of the most difficult items to estimate are the total use of power and water for the compressors. It usually is necessary to rely on experience obtained in previous installations. The data presented here are based on actually metered power and water used in the air conditioning system in the Union Guardian Building, Detroit, during 1931. The system has a capacity of 600 tons and cools 16 floors and 2 basements.

A frequently used method of computing the amount of power consumed by a compressor per year is to multiply the maximum rate of consumption in kilowatts by the number of hours per year that the cooled structure is to be occupied, and by an estimated load factor for the period considered. It is evident that the load factor will be different for the period from May 1 to October 31 than for the period from June 1 to September 30. A selected load factor therefore can apply only to a definite period.

The following table shows the amount of power and water used for various periods during 1931 at the Union Guardian Building.

†Air Conditioning Engineer, Union Guardian Building, Detroit.

Period	Hours of Building Use	Power: Total Kw. Hr.	Power: Aver. Kw.	Power: Load Factor	Water: Total Cu. Ft.	Water: Aver. Cu. Ft. Per Hr.	Water: Load Factor
May 1 — Oct. 31	1278	400,400	313	0.498	5,636,300	4400	0.499
May 15—Oct. 15	1068	390,700	366	0.582	5,520,630	5170	0.586
June 1—Sept. 30	858	359,800	419	0.666	5,077,940	5920	0.672

The figures headed Hours of Building Use were obtained by adding the number of hours elapsing from the time of starting business each day to the time of closing—normally 8½ hr. Total power and water figures were divided by the hours of use to get average rates of use for the various periods. The average power rates were further divided by 629 kw. (the maximum power load ever observed) to get the load factors. Similarly, the average water rates were divided by the maximum rate, 8820 cu. ft. per hr., to get the load factors for water.

Another method of estimating the annual consumption of power and water consists of multiplying the maximum rate of use by the number of hours the structure is to be occupied per day, and again by the estimated number of days per year that the machine can be considered to operate at 100% load. For example, the total power consumption in 1931 at the Union Guardian Building was 415,700 kw.-hr. Dividing this by 629 kw. and by 8½ hr. per day gives 78 days as the equivalent number of days per year that the com-

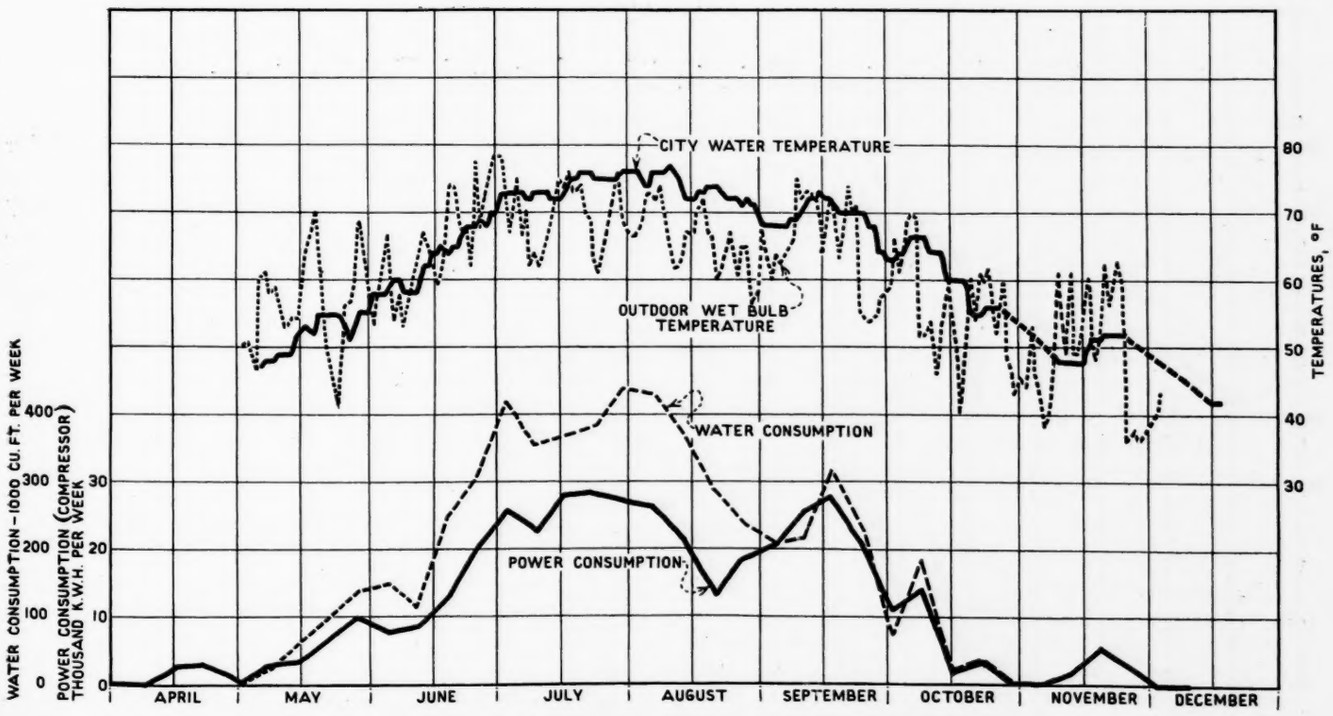


Fig. 1. Variation in power and water consumption through the week

pressors would have had to operate at 100% load to use the same total of power.

Limitations

The foregoing figures should not be used without realizing that they apply accurately to only one particular type of system, to one type of occupancy, and to Detroit's climate. Due consideration must be given to any difference in conditions, to make the figures of value.

To explain, the occupancy at the Union Guardian Building consists of bank and office space, open from 8:30 a.m. to 5:00 p.m. normally, open Monday evenings and closed Saturday afternoons. The compressors are started 1 hr. to 3 hr. before the offices open, depending upon the weather. This early starting causes the load factors shown above to be higher than those of a system operating a greater number of hours per day, due to the fact that the formula does not consider early starting time.

The fan system involved provides for not more than 50% outdoor air, there being no exhaust fans. A system which would permit the use of 100% outdoor air would be able to dispense with refrigeration during a few days in the spring and fall when the outdoor temperature ranged between 67° and 70° dry bulb, with a dew point of 54°. Such a system would have load factors just slightly lower than those shown.

A system which did not use direct expansion coils in the air washers, but used a Baudelot cooler and storage tank would also have a lower load factor. However, it would be penalized by having to operate at a lower suction pressure and by requiring additional compressor capacity due to heat gains in the storage tank and circulating pump.

The compressors at the Union Guardian Building consist of three 200-ton, vertical, three-cylinder, double-acting CO_2 compressors, equipped with clearance pockets on the upper ends of the cylinders. Opening the clearance pockets decreases the power consumption about 10% and the refrigerating capacity about 15%. It is possible, therefore, to make the compressor capacity fit the cooling load to a great extent. A system having a single compressor without any capacity reducing device, operating on direct expansion cooling coils, would have nearly a 100% load factor, computed on the actual number of hours when some degree of cooling would be needed.

The load factors for water, shown in the table, would have been lower if the maximum water rate had been greater. The maximum rate represents about 2 g.p.m. per ton of useful load, a greater rate being prevented by the falling off of city water pressure during the hottest months.

The curves, Fig. 1, show the variation in power and water consumption per week, using the same data from which the table was prepared.

The curve of city water temperature was prepared because of its value in estimating the use of water for condensers or for direct cooling of air. Maximum daily temperatures were used.

Maximum daily outdoor wet bulb temperatures occurring before 4 p.m. each day were used for the wet bulb curve shown. On Monday evenings when the system was operated, it frequently was found that the maximum wet bulb temperature of the day occurred in the evening.

The curves of city water temperature and wet bulb temperature follow each other sufficiently to suggest a relation between the two. It is reasonable to expect that the average daily wet bulb temperature (instead of the maximum) would affect the water temperature because Detroit obtains its supply from shallow Lake St. Clair, which presents a large evaporating surface.

Gas Conversions Gain in Manufactured Gas Territory

THE annual report of the Committee on House Heating and Cooling of the American Gas Association indicates that there was a 14% increase in the number of gas-fired central house-heating installations by manufactured gas companies from July 1, 1931 to July 1, 1932. The natural gas companies reported a 28% increase. Several manufactured gas companies showed large increases—The Washington Gas Light Company and Subsidiaries, 78%; Des Moines Gas Company, 78%, and the Consolidated Electric Light and Power Company of Baltimore, 18%.

Twenty companies reported house-heating saturation in excess of 1% of total customers. The average saturation for all reporting manufactured gas companies was six installations per 1000 customers, or 0.60%.

Many companies showed no increase, and nearly 50 companies reported small decreases in installations.

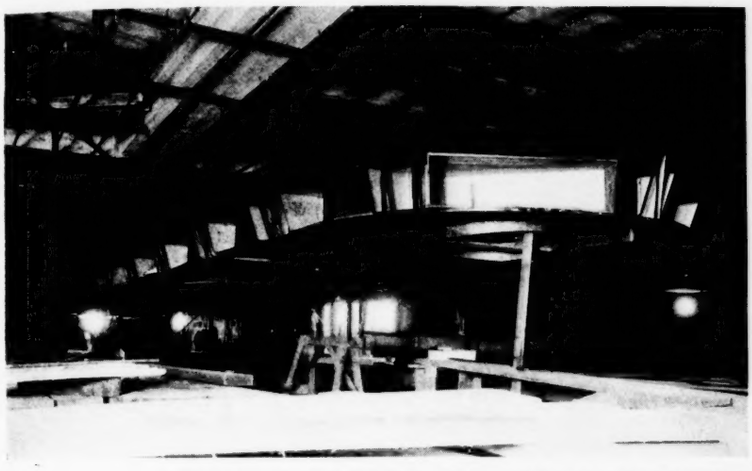
Among the natural gas companies the Pacific Gas & Electric Company showed an increase of 54%. The Argus Pipe Line Company (Kansas) showed an increase of 156%. At the present time 33.6% of this company's customers burn gas for house-heating. Other natural gas companies showing large increases included: Atlanta Gas Light Company, Public Service Company of Colorado, Kansas Power & Light Company, Kansas City Gas Company, Central Power Company (Nebraska), Iowa-Nebraska Light & Power Company, and Memphis Power & Light Company.

The average saturation for all reporting natural gas companies was 77 installations per 1000 customers, or 7.67%.

The increase in number of conversion installations by manufactured gas companies was 29%, or slightly more than double the increase in gas-designed installations in the same territories. In the natural gas territories the increase in gas conversion installations was 20%, or one half the increase in gas-designed installations for the gas companies. However, conversion equipment represents 70% of all installations reported by natural gas companies and gas-designed equipment represents 88% of the installations reported by manufactured gas companies.

Radio City

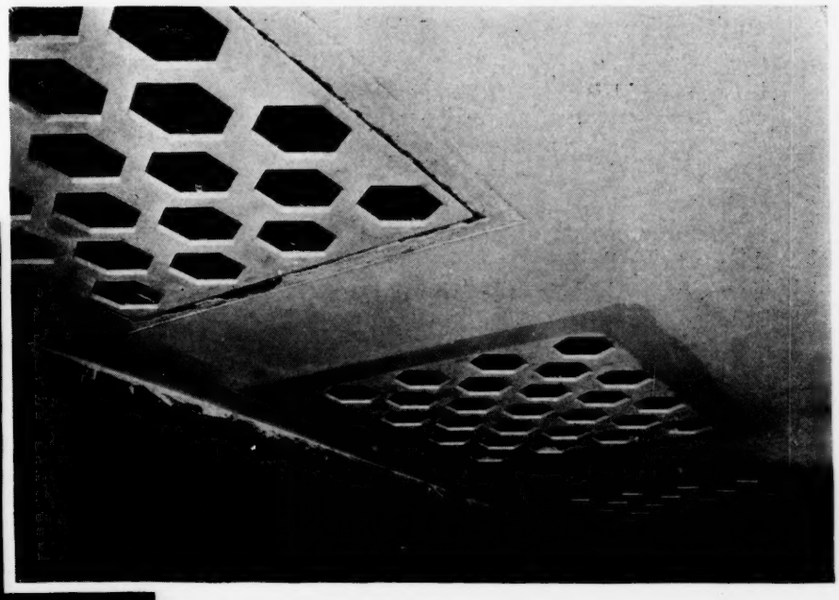
Progress photographs of some details of the air conditioning systems in the Radio City and Roxy Theaters in Rockefeller Center.



The view to the left shows the elaborate arrangement of duct work in the ceiling of the Radio City Grand Foyer. These ducts are part of the air conditioning supply. When finished, it appeared as shown in the upper part of the view to the right, its finish harmonizing with the colors in Ezra Winter's great mural, The Fountain of Youth. A close-up of this inlet is shown in the lower left-hand corner of this page.

(Above) Sound-proofed supply inlet in the rear of the new Roxy Theater in Radio City through which conditioned air is supplied. This duct was later covered by a false ceiling, shown to the right, the air being admitted to the room through moulded grilles.

A close-up of the Radio City Grand Foyer supply inlet, also shown at the top of the page.



Efficient Stoker, Redesign of Boilers and Instruments Modernize College Plant

By TELFORD R. DAVIS†

BALL State Teachers College, located near Muncie, Indiana, originally known as the Muncie Normal Institute, has rapidly grown since 1918 from one brick building and a dormitory to a fairly good-sized institution, comprising eight buildings with a total cubic content of 7,158,330 cu. ft., and its own heating plant.

The present heating plant was built in 1923 at a cost approximating $85,000, appropriated by the Indiana General Assembly. Since 1923, five additional buildings were built, a venture typical of the unprecedented growth of colleges and universities during the past decade.

This remarkable growth, coupled with natural depreciation, and consequently lower efficiencies, resulted in the need for increased expansion of the heating plant. The original plant consisted of three Vogt four-drum, bent-tube, low-head-room type boilers, each designed for a normal load of 298 hp. The stoker equipment consisted of natural draft chain grates with an effective grate area of 55 sq. ft. each, which was insufficient to obtain not much more than the normal ratings of the boilers themselves. A cross-sectional view of the original boilers and stokers is shown.

The procedure followed in diagnosing this plant's ills was first to make a complete survey of operating conditions by the observation of flow meters, evaporation, fire bed, heat demand, etc. A complete check was taken of the boiler flow meter readings and steam header pressures.

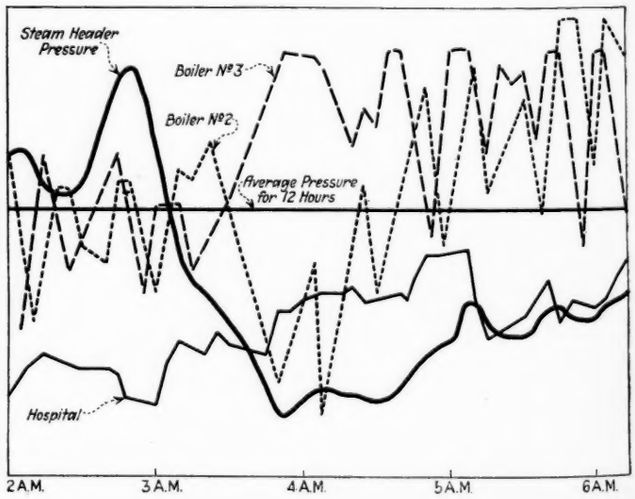
Flow meter charts were examined. Large fluctuations of load existed between the boilers. The charts, being of the round planetary type, were plotted out on a straight line graph, and astonishing conditions were disclosed which could not be so easily detected on the planetary charts. The flow charts of the various boilers were thus superimposed on this graph along with the steam header pressures, and results can easily be seen by observing a section of this chart taken between the hours of 2 a.m. and 6 a.m.

From the flow meter data it was apparent that something was radically amiss with combustion control, as it was evidently impossible to balance the load between boilers, and as a result each was struggling to gain control of the situation. It might be said that a discrepancy existed in the flow meter reading as all flow meter orifices are designed for a set pressure, and if this pressure varies flow recordings vary, and, consequently, will have to be corrected for the varying pressures. From the chart it can be seen that when the steam pressure dropped, the load apparently increased, as a given quantity of steam by weight increases in volume as the pressure decreases, and the velocity through the orifice plate correspondingly increases. When this correction was made, it was found that the load did not increase, as might be indicated, but remained practically constant.

In the analysis of this type problem, a close observation of firebed condition should always be made. On this particular survey it was noted that when two boilers were on the line at the same time under a rather heavy steam demand, one of the stokers was carrying fire over to the ash pit, while the other was seemingly operating normally—a bad case of unregulated combustion control.

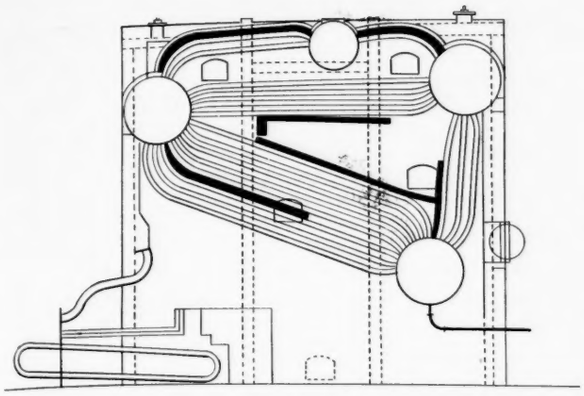
The main problem to solve first, however, was to increase the capacity of the present plant to handle properly the present steam load, and also provide for a future expansion program, which was estimated at 30% of the present load. This program, therefore, called for a complete redesign of the present hoilers, new baffling and stokers designed for 300% of the new normal rating of the boilers.

An increase in heating surface was accomplished by the addition of 71 3½-in. diameter steel tubes while present tube arrangements were changed. Essentially this new arrangement consisted of relocating the two top rows of tubes between the mud drum and from upper drum, one of those rows thus forming a support for baffling. Another important tube addition was a row

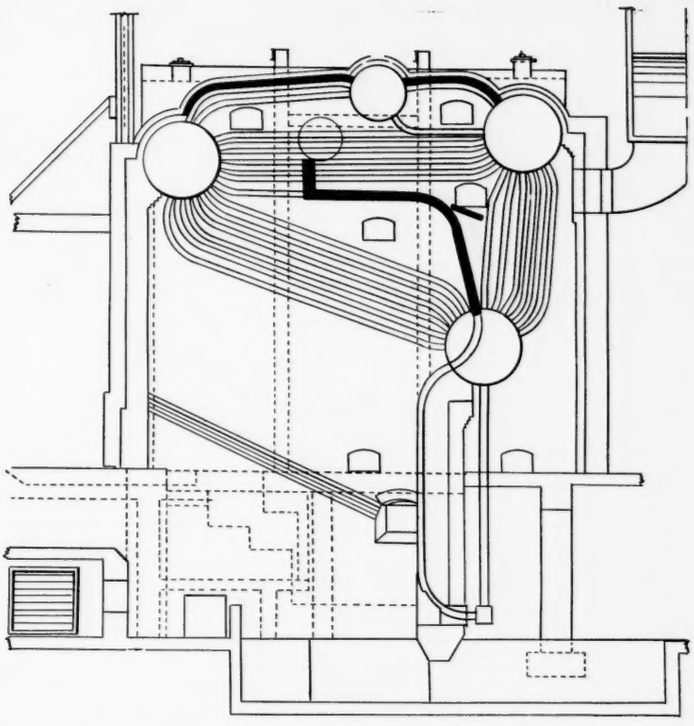


When the flow-meter readings were all plotted on one chart some astonishing conditions were disclosed

†Of the staff of Charles R. Ammerman, Consulting engineer, Indianapolis.



Section showing the boiler before the changes were made



(Right) Section showing increased height of boiler, with consequent greater combustion space, and change in baffling

installed leading out from the bottom of the upper steam drum and the upper rear drum. This last change insures the delivery of drier steam.

Forced draft is provided by a fan located centrally in front of the boilers. This fan blows directly down into a plenum chamber in which openings and dampers were provided to stoker wind chambers.

Under the original conditions of operation in the plant, control of combustion and stoker speeds was more or less a question of manual operation. This one factor in itself is one of the major causes of the poor operation of the plant, as it was practically impossible for the plant operator to keep his stoker speeds adjusted and hand-damper his plant under quickly fluctuating loads. With natural draft the operator's problems were made doubly difficult, because even with increased stoker speeds the air supply was not necessarily increased, which in itself led to improper combustion at the greater loads due to insufficient air supply or the reverse of too much air at decreased loads.

Under the plan of combustion control as adopted for this remodeled plan, one steam turbine-driven fan was installed to furnish air to a common plenum chamber located below the boiler room floor. Louvered openings were left between this plenum and the wind chambers of each individual stoker. The speed of the fan turbine is controlled by means of a balanced valve installed in the steam line to the turbine. This valve is adjusted so that its operation will lag behind the operation of the louvered dampers. These dampers are controlled from the usual type of over-fire draft control equipment set to control an over-fire draft at any predetermined pressure within 0.02-in. water pressure. Stoker speeds and smoke dampers are controlled by the accepted method directly through equipment regulated by steam pressures, each individual stoker being controlled through the pressure control equipment of its respective boiler.

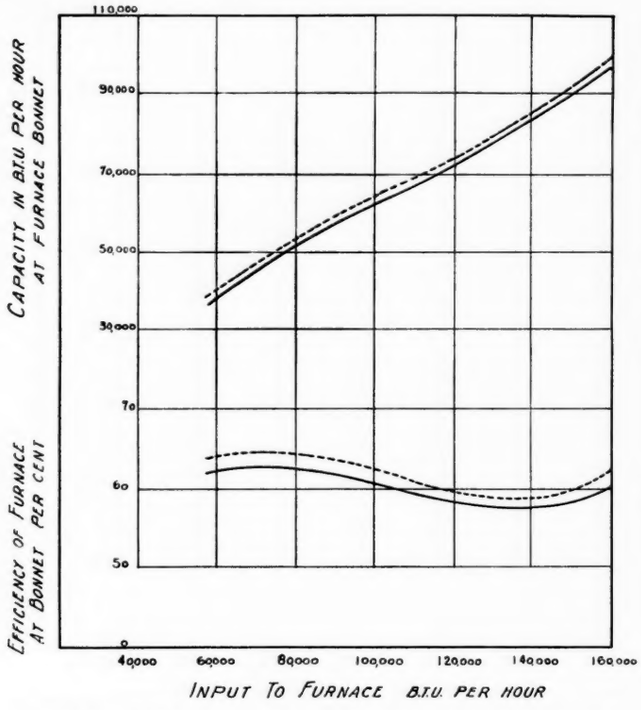
A summary of the remodeling work and recommendations for this plant is as follows:

1. Complete redesign of the boilers
2. Redesign of baffling
3. Additional combustion space
4. Heavier side walls
5. Efficient stoker
6. Automatic combustion control in order to eliminate the difficulty of load balance
7. Platform work to provide better working conditions around boilers

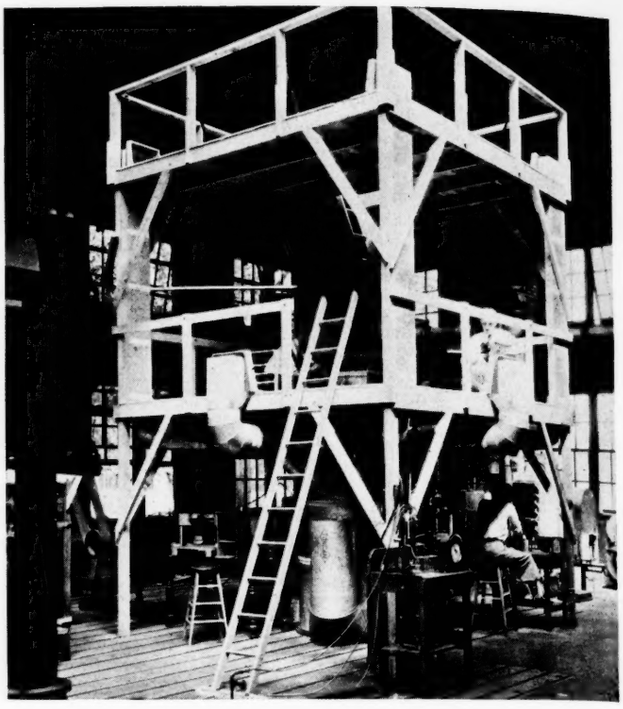
After these changes it is estimated that the actual boiler plant capacity will be increased from approximately 900 hp. to 1800 hp. at a cost of approximately $40,000. This cost also included considerable piping and general construction changes.

Filters Can Be Used in Gravity Warm-Air Systems

RESULTS of tests conducted by Prof. Frank B. Rowley, department of mechanical engineering, University of Minnesota, indicate the practicability of using viscous-coated glass wool filters in gravity warm-air heating systems. Having proved that these filters could be used effectively without blower equipment on gravity systems, Professor Rowley proceeded to determine the exact conditions under which the filters could be installed with the minimum of interference with furnace performance and economy.



Dotted lines show capacities and efficiencies of furnace before filters were inserted. Only a slight loss is shown by the solid lines, representing filter-equipped job



Gravity warm air plant set up in laboratory for filter test

His findings were that an installation of the filters in the cold-air return pipe of a gravity warm-air furnace will function satisfactorily *if the filter area is five times as large as the total warm-air pipe area.* Use of the filters in this manner resulted in a reduction of the heating capacity and heating efficiency by less than 2%, an insignificant decrease. This small reduction in efficiency occurs through losses from the furnace jacket as a result of the slightly higher temperatures prevailing when the filters are used.

Test apparatus was set up within a skeleton framework representing a two-story residence. Each floor was 12 ft. square with 8 ft. between levels, and the furnace was set up under the lower floor. Eight 12-in. leader pipes were taken off the bonnet, four of them terminating at registers on the first floor and four at registers on the second. Inlet air was carried to the furnace through three 18-in. return pipes equally spaced around the furnace. These were fitted with filter boxes, each equipped with three 16 in. x 25 in. viscous-coated glass wool filters.

A series of tests were run both with and without filters in the return pipes for capacities ranging from 60,000 B.t.u. to 160,000 B.t.u. input to the furnace. Accurate determinations were made of the total heat input to the system, the total air circulated in the system, the temperature rise in the furnace, and the stack gas losses, and from these data the performance characteristics of the apparatus were obtained.

The tests were sponsored by Owens-Illinois Glass Co.

How Farm Homes Are Heated

A survey of 1873 farm homes in 28 counties in different sections of the country made by a Committee of the President's Conference on Home Ownership and reported in Volume 7, *Farm and Village Housing*, published by that committee, showed that the factors primarily responsible for the type of heating equipment used in farm homes are climatic conditions, customs, and the economic status of the family.

Central heating systems are most commonly used in the New England-New York section, the Corn Belt, the Northern Dairy, and the Great Plains sections where the climate is somewhat rigorous.

Central heating systems are least used in the Cotton Belt, the fireplace being the most common source of heat in this region. Information is not available for the Pacific Northwest region.

Region	Per cent of total number heated by Stoves and Fireplaces	Per cent of total number heated by Central Heating Plants
New England-New York	70.2	29.8
Central East	86.3	13.7
Appalachian-Ozark Highlands	96.8	3.2
Tobacco-Bluegrass	93.9	6.1
Cotton Be't	98.5	1.5
Corn Belt	69.6	30.4
Northern Dairy	68.2	31.8
Great Plains	72.7	27.3
Great Basin	87.9	12.1

EDITORIALS

Following Up On Modernizing

Modernizing or rehabilitation or just plain repair—it makes little difference what you call it—has become of increasing importance as the months go by. Some are so much impressed by its possibilities that they have urged that it can replace new building under present conditions. This is hardly possible as only a little thought will show, for the same basic conditions which retard new building also act to retard making money available for repairs or modernizing. Only the most promising or the most necessary projects are being done, and consequently the obtaining of modernization jobs is not now, nor is it likely to be, any easy task. It takes work.

It scarcely seems possible that there is anyone in the industry who has not already given consideration to the possibility of finding modernizing work or who has not either worked out his own methods or else discarded it as a possibility. In finding modernizing jobs one of the saving graces is that the same building which did not need it last year may need it now, while the proposal which was turned down last year may be ripe now. Effective solicitation of this class of work calls for follow up. Most of the formal plans advanced for searching out modernizing work have not laid enough stress on this important point.

Cooling and the Mass Market

A year ago many people thought that the extensive use of mechanical refrigeration in dwelling cooling was upon us and that conditions had reached a pass where its adoption would give rise to a positive "demand" for its use. As a result of this belief equipment appeared and installations were made. According to statements of some of the leading technical men in the field the stumbling-block was the question "What will it cost?" When a prospective user heard the answer he was not interested.

Now this brings us to a disagreeable situation, but one that must be faced as a fact. Present costs are too high and must be reduced. How is this to be done? Careful observations by experts are that but little is to be gained by reduced manufacturing costs. About the only possibilities are reduced costs in distribution and servicing or else the development of new methods. Reductions in service cost and the development of new methods of cooling are distinctly engineering problems. The work of the engineer in adapting mechanical cooling to a mass market is thus by no means ended. Indeed it may be but scarcely begun.

One positive result which came out of the experience of last year is that the use of mechanical refrigeration for space cooling in residences is not yet at a stage where it has left the realm of engineering and become a purely merchandising and sales matter. Perhaps the experience will tend to direct attention away from merchandising and direct it back to engineering where it still belongs.

Building Deficiency

Just as we go to press complete and revised figures for the building industry during 1932 are coming to hand. The stabilization of material prices is notable and the accumulated deficiency of new building becomes more and more striking with each passing month. More and more it becomes evident that we are steadily improving what the financial writers are pleased to call the technical position. Actual activity continues its downward course but at a decreasing rate. So far as we are able to learn no well-informed statistician has as yet offered any prediction of the course of construction in the immediate future. We are now operating at about the 1918 level of activity when construction was artificially impeded by the war orders. One analyst, while venturing no prediction, goes so far as to point out that the stage is all set now that prices are at record lows while repairs and some renewals cannot now long be delayed without really serious loss of value. Regardless of the favorable position though, the troublesome problems of unrented space, no mortgage loans and defaults on existing obligations are still to be solved and a real upswing without such solutions is too much to expect. We can still be sure that the rapidly accumulating deficiency is working in our favor all the time.

Finding New Business

Our attention has been drawn to all kinds of methods which engineers and contractors have used during the past year or two to keep busy and to keep their organizations together. Perhaps no method is older than is the survey of existing buildings, or more often used, or more fruitful if used to advantage. Unfortunately some hesitate to use it either because it is off the beaten path, because it requires work of a different nature than that to which they are accustomed, or because they still cling to the belief that work should come without active solicitation or not at all. Undoubtedly it is hard work to find jobs by the survey method but we have at hand enough instances of its successful use to demonstrate that it has possibilities which the wide-awake man will not continue to overlook.

Abstracts . . .

Reviews and Summaries of . . . . Current Papers, Books and Pamphlets

Heat Transmission Test Data Now Available in One Book

STUDIES and tests of heat transmissions through building materials have been going on for a period of years at the University of Minnesota but the results were published piecemeal until collected in the recent Bulletin 9 of the Engineering Experiment Station.

The apparatus used is described in detail with figures illustrating the arrangements and the temperature-measuring electrical circuits. Three sets of apparatus are included: one for hot-plate determinations of conductivity, a hot-box method for overall transmissions, and a fan set-up for surface coefficient determinations.

The data resulting from the tests are clearly presented and are analyzed and discussed at some length. A considerable amount of space is devoted to showing that computation of overall coefficients from conductivity values results in values substantially similar to those obtained by test, if care is used in applying the proper coefficients to the computation.

Among the interesting points brought out is that the method of application of insulating materials has a decided effect on heat transmission through some constructions. In certain of the constructions where the same materials were used, and where the insulation was of flexible form, it was found that the heat transferred varied by as much as 50% between one or another method of applying the insulation. [*Title: Heat Transmission Through Building Materials; paper-covered; 106 pages; 63 illustrations; 6 in. x 9 in.; no price stated; authors, F. B. Rowley and A. B. Algren.*]

●

Oil Burner Performance Depends on Installer

PUBLISHED information on what may be expected of oil burners when installed in heating boilers is strangely meager in view of the large number of these burners in use. To some extent this is probably due to their rapid rise in popularity and to the fact that each installation has always been thought to be an individual problem to be solved on the site and through field adjustments. Because of this it has been recognized that correct installation is of prime importance.

Now comes a paper from the studies at Yale supported by the A.O.B.A. and the A.S.H.V.E., which, after reporting the results of tests made with oil burners in which air is supplied in various ways, concludes with the statement that "it is still true that the actual quality of performance conclusively rests upon those who install the equipment."

In this particular—as in others in the paper—it cannot be said that the tests resulted in findings not already pretty well known or predictable without actual testing.

The specific value of the paper is not the novelty of results but the clear statement of the facts of gas flow through a boiler and the suggestions made as a result.

The facts of gas flow are summarized as follows:

1. All gases resulting from combustion, as well as excess air and nitrogen, must flow through the boiler flues, the breeching or smoke-pipe and the chimney.

2. All the flow areas of these passages are fixed in amount.

3. The velocity of the gases through these respective parts, therefore, depends upon the volume of gases to be handled.

4. A certain pressure difference or draft will be required to achieve and maintain these velocities against the frictional resistance of flow.

5. The velocity varies as the square root of the draft head (Velocity = Constant $\sqrt{h}$)

The authors go on from this point with the following discussion.

"It is evident, therefore, that if twice the volume of gases results in one case as compared to another, due to different air adjustments, the draft required will be four times as great, even though the velocity is only doubled. Whereas this example may represent the difference between a good and a poor installation, the variation in draft requirement is so great that in practice the difference between a *moderately good* and an *only fair* adjustment may be critical if the chimney happens to be *weak*."

"The difficulties become cumulative. A poor adjustment calls for a higher oil feed due to reduced efficiencies, thus increasing the volume of flue gases. Furthermore, practically all of the tests to date have shown that an increase in excess air increases the flue gas temperatures. This merely aggravates conditions because the effect is to increase the volume of flue gases beyond that due to the excess air alone. Although this increased temperature may improve chimney draft to some extent, any resulting increment in draft will always be insufficient to produce the increment in velocity which the same event makes necessary."

"Furthermore, oil burners, with few exceptions, are set to produce the maximum heating load imposed by the heating system. This means that the chimney is expected at all times to handle comparatively large quantities of gases. This is another reason for not adding the *final straw* which in this case is excess air. It is not to be assumed from the foregoing that a great many chimneys are inadequate for oil burners. There are *border line* chimneys, however, that would prove

troublesome for any method of fuel burning and it is with these that care is required. If a draft condition is bad and no other improvement can be made, the excess air should be reduced if possible—perhaps the rate of oil feed also in extreme cases."

The summary of the factors which may limit the fuel-burning rate of an oil burner is also of interest.

General considerations

1. The heating load must in practice be the determining factor although there is a lack of uniformity in the allowances made to establish the total or gross heat output required. This should be corrected because the basic problem is one of heat loss from building structures—a problem essentially common to all methods of heat generating. This does not imply equal allowances in all cases but a determination by means of common method of approach.

2. The efficient heat absorbing rate of the boiler or equivalent device should be the most desirable limiting factor. Proper matching of Items 1 and 2 would secure high standards of performance.

Specific Considerations Relating to Oil Burner

3. The *furnace* size and design in conjunction with type of burner and effectiveness of mixing may impose a limit on fuel burning or heat release rate. There is no standard value, however—where 35,000 B.t.u. per cubic foot of net furnace volume per hour seems reasonable for one burner, 80,000 B.t.u. may be reasonable for another. Rates of 180,000 B.t.u. have been obtained with no apparent difficulty. It cannot be concluded that the limits have been satisfactorily explored.

4. The *oil supply* may be limited by pump capacity, size of orifice and fuel pressure, by primary air supply when the method of oil feed is dependent thereon, or by the total air supply no matter how obtained.

5. The *air supply* may be limited by fan capacity, size of air-supply openings and also by available furnace draft.

The full conclusions appended to the paper are as follows:

1. In a burner which receives its air supply by natural draft exclusively the quality of combustion is very sensitive to draft fluctuations. This is important because of the adverse effect on efficiency. In practice the supply of air could be either too great or insufficient unless carefully adjusted and precisely regulated thereafter. During intermittent operation its stand-by or off-period losses will run higher than other burners.

2. A burner which receives its air supply exclusively from a fan will generally be the least sensitive to draft changes and more satisfactory during intermittent operation. This will differ in degree depending upon the relative resistance which the fan and other parts set up to the flow of air during the off-period.

3. Intermediate types will generally occupy the middle ground between the preceding two. There will never be a sharp line of demarcation and a certain amount of overlapping is to be expected.

4. If a means could be found to stop the flow of air through a boiler during the off-period regardless of type of burner the foregoing differences on intermittent operation would virtually disappear and the average efficiency would be increased.

5. Where unsatisfactory draft conditions are encountered, excess air should be reduced as much as practicable, the furnace draft should be kept reasonably low and provision should be made for automatic draft regulation.

6. If the maximum fuel burning rate proves to be insufficient for the job it may in some cases be raised by reducing the excess air. Furnace alterations to secure better mixing and combustion may also be necessary.

7. The greatest improvements and the hope of maximum success lie in the field of installation.

[*Title: Air Supply and Its Effect on Performance of Oil Burners and Heating Boilers, by L. E. Seeley, J. H. Powers, and E. J. Tavanlar. About 2500 words with charts and graphs. A.S.H.V.E. paper, annual meeting, 1933.*]

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Sizing Steam Piping

THE complexity of the conditions under which flow occurs in the returns of heating systems has made the proper sizing of this piping a difficult problem. Because of lack of information the sizing has always been largely empirical although formulas for flow have aided in arriving at conclusions.

For some time this general problem has been under investigation under the auspices of the A.S.H.V.E. research organization.

A recent paper reports results of studies made on a laboratory set-up of piping and radiators through which known quantities of air and hot water could be circulated under definitely established pressure drops. The setup permitted large variations in both the proportions of air and water flowing and in the pressure drops. Data resulting show the relation between these variables for the setup used and a formula is included whereby these relations can be determined. Tables were prepared showing the quantities of water flowing at various pressure drops and with various proportions of air and water in the return piping when set up as dry returns of sizes from ¾ in. to 4 in.

Evidently these tables could be used as the basis for determining proper sizes for dry return piping if the critical conditions of flow in actually operating systems were known. While the paper mentions the fact that studies in operating plants are now under way to determine these conditions, the paper itself includes no such figures. Until these conditions can be established the tables are not useful. In the mean time the material serves as an intermediate step in making design information available for practical use.

The data presented in this paper tend to indicate that the amount of air flowing in the return system even under high vacuums is not great during normal operation. Obviously though, these quantities are so greatly affected by the workmanship of the pipe erection and by the number of fittings that a conclusion to the effect that air quantities in actual operation resemble those of the laboratory tests is premature. [*Title: Flow of Condensate and Air in Steam-Heating Returns by F. C. Houghten and Carl Gutberlet. A.S.H.V.E. paper, annual meeting, 1933. About 4500 words, illustrated with tables and charts.*]

News of the Month

Government Completes Uniform Mechanics' Lien Act

In a report to the Secretary of Commerce, the Standard State Mechanics' Lien Act Committee of the Bureau of Standards recommends for adoption by the legislatures of the several states a Uniform Mechanics' Lien Act said to provide a more equitable basis for liens against real property by laborers, vendors of material, subcontractors, and others engaged in building construction and related work.

Drafting of the act by the committee completed a study which has been of eight years' duration. In the report it is stated that effort has been made to safeguard the interests of the owner at every step, and at the same time to accord to the contractor, the subcontractor, the material man, and the laborer a facility for filing and proving their liens, so as to insure security to them upon the real property for which their work or materials were furnished, or upon a bond substituted for it.

It is provided that the parties involved may enter into an informal procedure which conforms closely to modern business practice in the building industries in order that difficulties may be adjusted without resort to the public record. Avoidance of a lien action is advantageous to all parties through the saving of expense, delay, and annoyance, the preserving of business reputation, and maintaining the titles clear.

Edison Electric Institute Organized To Supplant N. E. L. A.

Formation of the Edison Electric Institute, a new trade association which will shortly supplant the present National Electric Light Association, was announced January 11. The purpose of the new organization is said to be the purging of the industry of certain evils that have grown up in some of the companies such as the looting of operating companies by holding companies, publication of inaccurate and obscure financial statements, and the injudicious use of propaganda.

The executive committee of N.E.L.A. scheduled a meeting for the end of January, to discuss the winding up of that organization's affairs. Eighty-five percent of the contributing membership of the association have signified their intentions to support the new institute.

Troxell New Sales Manager for McCormick

Edgar R. Troxell, Jr., formerly New York manager for the Spencer Heater Co., Williamsport, Pa., has been appointed sales manager for J. H. McCormick & Co., Williamsport, Pa., manufacturers of air conditioning systems. Mr. Troxell will be located in New York, with headquarters at 4305 Chrysler Building.

Rutgers Offers Home Study in Air Conditioning

Rutgers University, New Brunswick, N. J., is inaugurating a new and modern home study course in air conditioning, to be conducted through the facilities of the University Extension Division. The material will be presented in 12 sections, and will commence with fundamental principles and progress to the more advanced technical considerations in the later sections. Complete information may be obtained by addressing the University Extension Division of the university.

A fee of $18, payable upon registration, covers the cost of the course, including text material, lesson assignments, and correction service.

Blankin To Head Philadelphia Group

Merrill F. Blankin, president, Haynes Selling Co., Philadelphia, was elected president of the Philadelphia Chapter, A.S.H.V.E., at its annual meeting, held January 12. Other officers for 1933 are: vice-president, William P. Culbert; secretary, W. Roy Eichberg; treasurer, J. H. Hucker. L. C. Davidson, W. F. Smith, and A. McClintock, Jr., were elected to the board of governors.

Anthracite Production Drops

Anthracite production for 1932 is estimated by the Bureau of Mines at 49 million tons, as compared with nearly 60 million tons in 1931.

Ventilation in Public Carriers Under Investigation

Encouraged by the considerable interest aroused by his circular letter of inquiry as to prevailing conditions in New York's various transportation facilities, Ely Jacques Kahn, architect, New York, recently invited a group of engineers and architects to cooperate with him in a further informal study of the subject. Efforts for the present will be directed toward obtaining the opinions of experts and stimulating the interest among civic groups and individuals on the dangers to public health incurred by improper and inadequate ventilation in subway trains, street cars, buses, taxicabs, ferry boats, and other public conveyances.

Among those having expressed an interest in the movement are: Alfred Jaros, Jr., Dwight D. Kimball, and Clyde R. Place, consulting engineers; Theodore R. M. Gerdes and Chauncey Matlock, ventilating engineers.

Midwest Power Show Scheduled for June

The Sixth Midwest Engineering and Power Exposition will be held in Chicago during the week of June 25-30, instead of in February as formerly, in order that it may coincide with the date of Engineering Week at the Century of Progress Exposition.

Educational features of the show will be sponsored by Armour Institute of Technology, Chicago, under the direct supervision of George F. Gebhardt, professor of mechanical engineering. Early indications point to a complete utilization of

the 85,000 sq. ft. of floor space at the Coliseum Building for exhibits of machinery, tools, heating and air conditioning equipment, etc.

Utah Distributor for Barber-Colman

Barber-Colman Co., Rockford, Ill., announces the appointment of a distributor in the Salt Lake City territory for its electrically-operated temperature control equipment.

Rushby C. Midgley, Dooly Building, Salt Lake City, Utah, will handle the line in Utah, southern Idaho, and western Wyoming.

Kreitner with Building Expense Control

William G. Kreitner has been appointed vice president in charge of heating and ventilating of the Building Expense Control Co., Inc., building managers of numerous office and apartment buildings in New York.

Mr. Kreitner was formerly heating engineer with the Modine Manufacturing Company, and prior to that he was for five years engineer in charge of construction and service for the Milwaukee Valve Company.

Patterson Enters Stoker Field

The Patterson Foundry & Machine Co., East Liverpool, Ohio, announces its entrance into the stoker field. Stokers will be built in a number of types from domestic to large industrial sizes.

The Homer-Read Co., 105 Vandergrift Building, Pittsburgh, has been appointed distributor for the company's stoker in the Pittsburgh territory. Other appointments are: Horace S. Bracken, Johnstown, Pa., the Johnstown territory, and R. W. Matthews, 770 Girard Street, N. W., Washington, D. C., the District of Columbia.

Western Engineers Arrange Air Conditioning Conference

Practical and theoretical aspects of air conditioning will receive consideration at the Western Conference on Air Conditioning, scheduled for February 9-10 at the University of California, Berkeley, under the auspices of the San Francisco Section, American Society of Mechanical Engineers.

The program has been tentatively arranged as follows:

February 9

9:00 a.m.—Registration.
Basic Theory of Air Conditioning, L. Washington.
The Psychrometric Chart and its Use, C. R. Dodson.
Physiological—Psychological Basis of Comfort, C. W. Brown.
What is Comfort? Leo Hungerford.
2:15 p.m.—Analysis of Cooling Fundamentals, Walter S. Weeks.
Insulation and Heat Capacity in Relation to Heat Transfer.
Cooling with Ice in California Valley Summer Weather, H. L. Lincoln.
6:30 p.m.—Dinner meeting at Engineers' Club, San Francisco.
Tentative subject — Incidence of Respiratory Diseases and Weather.

February 10

9:30 a.m.—Design Procedure for Heating and Cooling Installations, W. E. Leland.
Air Filtration, F. W. Kolb.
Control and Regulation, T. B. Hunter.
2:15 p.m.—The Architect's Problems in Heating, Cooling, and Ventilating, J. J. Donovan.
Air Infiltration through Windows, L. M. K. Boelter and Virgil H. Cherry.
Cooling Rural Homes—A Study in Progress, B. M. Woods and associates.
Psychology of Selling, E. K. Strong.

News of the Month

Uhl New Agent for Penn Switch

Penn Electric Switch Co., Des Moines, Iowa, has made Uhl Co., 132 S. Tenth St., Minneapolis, its exclusive representative in Minnesota, North and South Dakota. A small stock of the company's controls will be maintained.

Coonley New President of A. S. A.

Howard Coonley, president of The Walworth Co., New York, has been elected president of the Amer-

WILL PHOTOGRAPHS BE USED TO SHOW HEAT DISTRIBUTION IN ROOMS?

The view to the right shows a photograph made by an hour's exposure of a film sensitive to infra-red rays. The room was in perfect darkness, the invisible infra-red rays being supplied by the two electric irons, which did not glow. Future improvements in this method might enable engineers to photograph a darkened room to determine its heat distribution.

International News Photo

News of the Month

ican Standards Association for 1933, succeeding Bancroft Gherardi. Election of F. E. Moskovics, chairman, Marmon-Herrington Co., Indianapolis, to the post of vice-president of the association has also been announced.

Frank Russell to Direct Capitol Insulation Division

Frank C. Russell, recently made manager of the newly organized Capitol Rock Wool Insulation Division of Standard Lime and Stone Co., Baltimore, has announced that the company will manufacture a complete line of insulations in two newly-equipped plants at Millville, W. Va. The line of products will include both building insulation and pipe heater insulation. Mr. Russell, who was formerly president of the Mineral Felt Insulating Co., Toledo, Ohio, will maintain headquarters in Baltimore.

Historical Documents to be Preserved in Conditioned Building

The National Archives Building, now under construction in Washington, D. C., will be air conditioned by seven complete systems which will supply 315,000 c.f.m. of conditioned air. Four York compressors will supply the necessary 1000 tons of refrigeration.

The building will contain approximately 4,000,000 cu. ft. of conditioned space in which valuable documents and books will be preserved. Even temperatures and proper relative humidities will be maintained to protect papers and bindings from excessive dampness and drying out.

Clyde R. Place, New York, is consulting engineer on the mechanical equipment.

Clark Urges Market Study for Chicago Oil Burner Dealers

At a regional meeting of the Chicago Oil Burner Association, held January 10, in the Hotel Stevens, Chicago, A. W. Clark, managing secretary of the Dealer Division, American Oil Burner Association, stressed the need for concerted action on the part of the group, in disseminating information with respect to the local market, and promised the facilities of the association in the solution of its problems.

W. A. Matheson, president of the Chicago association, preceded Mr. Clark's talk with a brief discussion of the relations between the association and local dealers, showing in what respects the national association could assist dealers in preparing the market for increased acceptance of the industry.

American Radiator Helps Dealers Get Business Now

The Heating & Plumbing Finance Corporation, American Radiator subsidiary, has announced a new arrangement in their time payment plan to help qualified dealers overcome the universal tendency of home owners to postpone the purchase of heating equipment, and get business now.

According to the new arrangement, qualified users of this time payment plan are allowed to make installations now and for the rest of the heating season, with suspension of all monthly payments for a period of six months. The initial down payment is all that is required.

It is pointed out that this arrangement was made at the direct solicitation of dealers who claimed that it would enable them to overcome the argument of the owner "I'd like to have it but I must wait till later to buy."

COMING EVENTS

JUNE 12-17, 1933. Tenth Annual Convention of the American Oil Burner Association, to be held in Chicago. Headquarters at the Hotel Stevens.

JUNE 19-22, 1933. Fifty-First Annual Convention and Exposition of the National Association of Master Plumbers, to be held in New Orleans, La.

JUNE 25-30, 1933. Sixth Midwest Engineering and Power Exposition, to be held in Chicago.

JUNE 27-30, 1933. Twenty-Fourth Annual Convention of the National District Heating Association, to be held in Chicago. Headquarters at the Palmer House.

JULY 25-28, 1933. Annual Convention of the Heating and Piping Contractors National Association, to be held in Chicago.

SEPTEMBER 25-29, 1933. Fifteenth Annual Convention of the American Gas Association, to be held in Chicago.

Home Furnace Appoints Smith Service in Detroit

Smith Oil Burner Service, 12217 Hamilton Ave., Detroit, specialists in oil burner installation and servicing of all types of burners at flat contract rates, has been appointed Detroit distributor for the Home Furnace Co., Holland, Mich.

Officers of the service company are W. O. Smith, general manager, and George Martin, sales manager.

Morehouse Receives N. J. Public Service Appointment

H. Preston Morehouse has been appointed general air conditioning representative for the Public Service Electric & Gas Co., Newark, N. J. The post of industrial fuel representative for the Essex Division, vacated by Mr. Morehouse, will be filled by C. S. Cronkright, formerly industrial fuel representative for the Newark district.

Century of Progress to Celebrate Engineering Week

Arrangements are in progress for "Engineering Week," to be held during the last week of June, 1933, in connection with the Century of Progress Exhibition at Chicago. A joint committee representing the various engineering societies has been formed to stimulate interest in this endeavor and to formulate plans for the event. This should prove an occasion of international importance, as many scientists and engineers of world renown will be in Chicago at this time. Other large engineering and power activities for the same week are projected.

Sheffler-Gross to Distribute Buckeye Products

Sheffler-Gross Co., Drexel Bldg., Philadelphia, has been appointed

exclusive distributor in the Philadelphia territory for industrial products of the Buckeye Blower Company, and not for products of John J. Nesbitt, Inc., as was stated in these pages last month.

New Sales Managers for Richmond Radiator

Richmond Radiator Co., Inc., New York, announces the appointment of Allen P. Livar as general sales manager; E. A. Schwerdtle as sales manager of its enameled ware division, and Don D. Smith as sales manager of the new pottery division.

Spencer Heater Appoints Ahlff in New York

Spencer Heater Co., Williamsport, Pa., has appointed A. A. Ahlff New York sales manager. For the past seven years Mr. Ahlff has been in charge of Spencer's sales in the Buffalo territory.

Modernization Receives Local Support

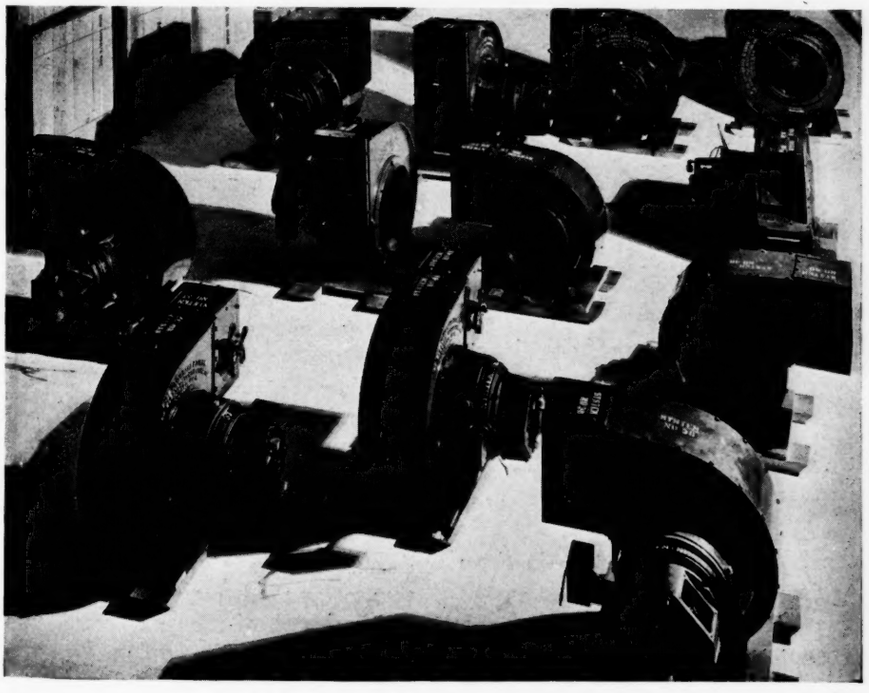
Reports received by the United States Department of Commerce indicate that local chambers of commerce, women's clubs, veterans' organizations, and various professional and fraternal societies in some 80 cities and towns throughout the country have sponsored community improvement campaigns to increase comfort and attractiveness in the home, and at the same time to increase employment of local building tradesmen. A creditable degree of success in this work is reported.

Chicago Groups Hear Macintire on Refrigeration for Air Conditioning

Two hundred members and guests of the Illinois chapter, A.S.H.V.E., and the Chicago section, A.S.R.E., assembled for a joint meeting, at the Sherman Hotel, January 9, to hear H. J. Macintire, professor of refrigeration at the University of Illinois, speak on "Refrigeration and Its Application to Air Conditioning." Professor Macintire's lecture included a brief historical sketch of the development of mechanical refrigeration, discussion of the thermodynamic processes involved, various types of apparatus, and refrigerants used.

In concluding, the speaker described the experiments in comfort cooling carried on at the research residence at Urbana, and reported results obtained by the use of ice for this purpose. He urged upon his listeners the importance of exercise of care in the installation of comfort cooling equipment, pointing out that relative humidity and air motion must be considered as well as dry bulb temperature.

Samuel R. Lewis contributed a brief talk on "Air Cleaning Devices."



A few of the special marine-type IIg blowers for the four new ships of the Grace Line—the Santa Rosa, Santa Paula, Santa Lucia and Santa Elena—which will ply between New York and California. Each vessel will have an unusually complete ventilating system. The total order involved 224 direct-connected blowers, which altogether will handle over 100 million cubic feet of air per hour.

Georgen-Mackwirth Has Roof Ventilator Department

Georgen-Mackwirth Co., Inc., 817 Sycamore St., Buffalo, N. Y., recently opened a roof ventilator department, where rotary, power-driven, inverted cone and standard stationary ventilators will be designed and manufactured.

National Radiator Opens Warehouse in Philadelphia

National Radiator Corporation, Johnstown, Pa., has opened a warehouse in the Milne Building, Washington Avenue, between 10th and 11th Sts., Philadelphia, where a complete stock of the company's boilers, radiators and specialties will be carried.

Underwriters Issue Warning on Range Burners in Furnaces

A warning in connection with the installation of stove and range burners in house-heating furnaces has been issued by the National Board of Fire Underwriters, Committee on Fire Prevention and Engineering Standards. These burners are said generally to embody principles of operation and means for preventing abnormal discharge of oil at the burner which are not recognized as suitable for use in warm-air furnaces or steam or hot water boilers, and the recent tendency for their application to this purpose has been viewed with concern by the board.

Complete information on this subject in the form of detailed reg-

ulations governing the installation of oil burners in furnaces is available, and can be had by addressing a request to the National Board of Fire Underwriters, 85 John St., New York, or the National Fire Protection Association, 60 Batterymarch St., Boston, Mass.

Myers New Buckeye Agent in St. Louis

Buckeye Blower Co., Columbus, Ohio, has appointed Mr. George Myers, St. Louis Mart Bldg., St. Louis, Mo., as its representative for the company's line in the St. Louis district.

Distillate Burner Makers to Have Headquarters with A. O. B. A.

At its quarterly meeting, held at the Stevens Hotel, Chicago, January 9, the board of directors of the American Oil Burner Association adopted a report from R. M. Sherman, president of the Distillate Burner Manufacturers Association, which will locate the headquarters of this group within the offices of the A. O. B. A. at 342 Madison Ave., New York. The distillate organization will retain its own identity, but will be enabled to increase its cooperation with the power burner branch of the industry, making it possible to eliminate much duplication of effort on those matters where interests of both groups converge.

A. W. Clark, managing secretary of the dealer division of the A.O.B.A., and Harry F. Tapp, executive secretary of the A.O.B.A., will become respectively the managing secretary and treasurer of the Distillate Burner Manufacturers Association.

W. J. Smith, Cleveland Steel Products Corporation, and chairman of the A.O.B.A. Committee on Cooperation with the Underwriters' Laboratories, was appointed to act as spokesman for the industry before the underwriters' group. This subsequently led to an agreement on a definite policy by the underwriters as to the principle of undivided manufacturer responsibility with respect to control of listed burners.

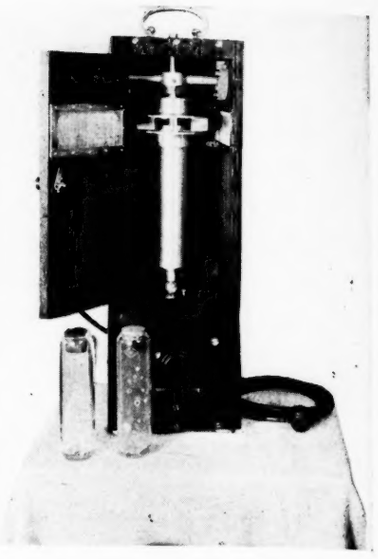
Kelvinator Corp., Detroit, Mich., was accepted to membership in the association at the meeting.

Braemer and Smith Open Engineering Offices in Philadelphia

William G. R. Braemer, pioneer manufacturer of humidifiers and other air conditioning apparatus, and J. H. Smith, formerly superintendent of construction and chief engineer of the Ballinger Company, Philadelphia, have become associated as engineers, specializing in industrial plants, power plants, refrigerator plants, heating, ventilating, and air conditioning. Offices have been opened at 1265 Commercial Trust Building, Philadelphia.

Following a long experience in the industry, Mr. Braemer organized in 1917 the Braemer Air Conditioning Corporation which took over the air conditioning division of Warren Webster & Company, and which later was taken over by Carrier Engineering Corporation. Following this, he was chief engineer of the American Moistening Company, also being consulting engineer for the drying division of Grinnell Company, later being consultant for the Niagara Blower Company. For several years he was chief engineer of the Universal Humidifying Company, believed to be the first manufacturer of an electrically-driven home humidifier.

During his 19 years of association with the Ballinger Company, Mr. Smith designed mechanical equipment for a large number of buildings, among which were the Edward G. Budd Mfg. Company, Atwater Kent, Victor Talking Machine Company, and American Chicle Company plants; hospitals in York, Easton, and Bloomsburg, Pa., etc. Prior to that time he was assistant chief steam and hydraulic engineer with Pittsburgh Crucible Steel Company, and designing engineer with E. I. Du Pont de Nemours Company.



Counts Bacteria in Air

This apparatus, developed by William F. Wells, sanitary engineer, Harvard University School of Public Health, draws in a measured sample of air and separates out the bacteria and other fine particles, depositing them directly on the collecting medium so that they can be counted without separate plating. It utilizes the principles of the centrifuge.

Refrigeration Talks Attract Large Group to New York Meeting

A symposium on refrigeration was presented at the regular monthly meeting of the New York chapter A.S.H.V.E., held in the Building Trades Club, January 16, at which nearly 200 members and guests were present. Five speakers were scheduled, each to present a different phase of the subject as it is related to air conditioning, and each limited to 30 minutes.

W. L. Fleisher opened the program with a general outline of refrigerating apparatus, pointing out that refrigeration for comfort cooling differs from refrigeration for industrial processes, in that in the former case humans are more adaptable to temperature change than are the various processes, and that the cooling consists in reducing the temperature but a few degrees. The speaker showed why the steam ejector system is ideal, where applicable, for air conditioning work.

R. W. Waterfill followed with a discussion of the steam ejector system, as applied to railroad cars, and a description of the centrifugal type of compressor, in which he outlined the merits and advantages of each. C. A. Bulkeley then compared the air washer method of cooling with the cooling coil method, in which he pointed out the advantages

of the latter. C. F. Holske presented some interesting figures to show how the use of ice is economically feasible, and often superior to mechanical refrigeration in certain applications, notably when the system is operating at a low load factor. The concluding speaker was E. W. Legier who discussed unit air conditioners.

A. I. E. E. Gives Attention to Railway Air Conditioning

A comprehensive discussion of the problems encountered in equipping railway cars with air conditioning apparatus was presented in a paper, "Application of Air Conditioning to Railroad Passenger Cars," by W. C. Goodwin and Charles Kerr, Jr., both of Westinghouse Electric and Manufacturing Company, which was read by Mr. Kerr at the Winter Convention of the American Institute of Electrical Engineers, New York, January 23-27.

It was pointed out that it is impractical to accomplish all the things on a railroad car that can be done in commercial installations, due to the limitations in available power supply and space. However, experience has shown that comfortable conditions, which in general approach the best industrial and residential practice, can be provided on a railroad car. The ideal equipment for railway work must combine lightness of weight with reliability and mechanical ruggedness, and must occupy a minimum of space.

The speaker stated that experience has shown that for outside temperatures of 95° and above, comfortable conditions will prevail within the car if the temperature be held at 82° with a relative humidity of 60%. To meet these requirements, a wide variety of compressor capacities would be needed for the many different sizes and types of car. Since this is not an economical procedure from the manufacturing standpoint, it has been found that a 6-ton compressor, driven by a 12-hp. motor will be satisfactory for the average car.

Considerable difference of opinion exists as to whether belt-drive or gear-drive is preferable, but it is the opinion of the writers of the paper that the latter is superior. This, however, necessitated the development of a generator of 15-kw. capacity of such dimensions that it could be installed in the limited space provided in the standard railway truck.

A high speed compressor has been developed to meet the conditions of this work. This compressor is equipped with feather valves and has forced lubrication throughout. The condenser is air-cooled. A combination alternating and direct current motor, mounted on one shaft was developed, so that the compressor could be operated from a standard power outlet when standing in yard or terminal.

There is a tendency at present to eliminate ducts in the distribution system, the conditioned air being discharged into the car at the ends. The total weight of the equipment described by the paper was approximately 6000 lb.

Bureau on the Air

The need for modernizing of heating and plumbing is the subject of a series of radio broadcasts which started January 17 under the sponsorship of the Plumbing and Heating Industries Bureau.

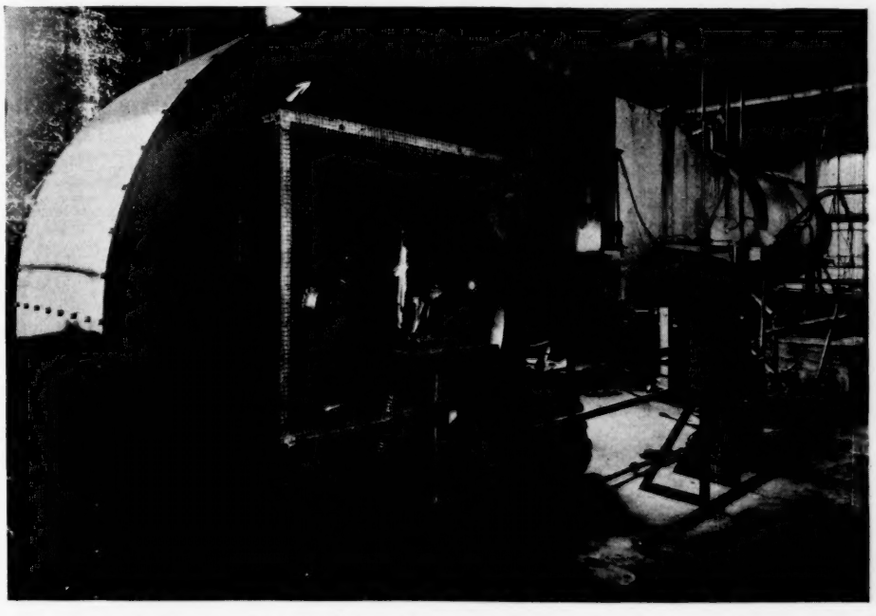
Mrs. Louise Bargelt, home building editor of the *Chicago Tribune*, gave the first talk over station WGN, Chicago. The broadcast was made in connection with the 40th annual convention of the Illinois Master Plumbers Association.

News of the Month

A. S. A. Adopts Standards for 150-lb. Pressure Steel Flanged Fittings

A revised code of standards for steel flanged fittings and companion flanges as sponsored by the Heating and Piping Contractors National Association, the Manufacturers' Standardization Society of Valve and Fittings Industry, and the A.S.M.E., has been approved by the American Standards Association. Fittings for 150 lb. per sq. in. maximum steam service pressure at 500°, including companion fittings, have been added, and the maximum service pressure rating has been raised from 1350 lb. to 1500 lb. per sq. in. Revisions have been made in standards for fittings for pressures ranging from 300 lb. per sq. in. to 1500 lb. per sq. in., at 750°.

These are based on the American standard for 125 lb. cast iron flanges and flanged fittings, with the following changes: The minimum metal thickness of fittings has been reduced in all sizes of fittings; in sizes 14 to 24 in., inclusive, the port diam-



Convector heaters are tested in this wind tunnel in the laboratory of the McCord Radiator & Mfg. Co., Detroit, Mich.

eters of fittings have been reduced; a 1/16 in. raised face has been provided, which is included in the flange thickness minimum.

The Weather Cycle

When a year ago the twelve months of 1931 closed with an average daily excess in temperature of 3.0° at New York, it was thought to be the climax of a period of warm weather extending over five years which had been growing steadily warmer since 1927. It seemed a reasonable inference that during 1932 the pendulum might swing the other way, and the year would close with a deficit in temperature. The records of the Weather Bureau show that the mean temperature for the year was in excess of the normal as follows: At Boston, 2.8°; New York, 2.0°; Pittsburgh, 0.7°; Chicago, 1.4°; and at St. Louis, 1.2°.

Comparing these departures from normal with corresponding figures of a year ago, it may be said that 1932 was 2.0° cooler than 1931 in the Middle West, and 1.0° cooler in Eastern States.

As this issue goes to press January already has an excess for the New Year. At this rate the slow process of returning to normal temperature may extend the prevailing warm period beyond another twelve months. And yet how fickle is Boreas! A change to subnormal temperature may set in at any time.

Constitution Revision Features Opening of A.S.H.V.E. Convention in Cincinnati

As we go to press, the 39th annual meeting of the A.S.H.V.E., January 23-25, is off to a promising start in Cincinnati with an attendance of 250, an enthusiastic reception of several important technical papers and considerable discussion of the proposed constitution changes. President K. A. Wright of the Cincinnati chapter opened the program by introducing Anthony Dunlap, who welcomed the gathering to the city in the absence of the mayor. Professor Frank B. Rowley, retiring president, followed with a response to the greeting.

The first paper of the meeting was a "Study of the Application of Thermocouples to the Measurement of Wall Surface Temperatures," by A. P. Kratz, and E. L. Broderick, research professor and research assistant, respectively, at the University of Illinois.

The latter read the paper. Two methods of installing thermocouples were described. In the first, the thermocouple is placed on the surface and the junction, and several inches of the leads are covered with thin adhesive vellum. In the other method, the junction and several inches of the leads are imbedded in a scratch made in the surface, and sealed in place with plaster of paris, shellac, or similar material. The wire and sealing material is worked flush with the surface. While very fine wires are preferable for both methods, wire as large as No. 2 B & S gauge is sometimes used for the second.

As a result of the experimentation, it was concluded that a thermocouple made of wire as fine as No. 34 B & S gauge, having the junction and 3 in. of the leads embedded in the surface and sealed flush with the surface with cement or plaster of paris, for all practical purposes indicates the true temperature of the surface. Also, a thermocouple made of wire as large as No. 22 B & S gauge, having the junction and 4 in. of the leads embedded in the surface and sealed flush with the surface with cement or plaster of paris, indicates a temperature somewhat lower than the true temperature of the surface. A thermocouple made of wire as fine as No. 34 gauge placed on the surface and having the junction and 3 in. of leads covered with thin vellum indicates a temperature lower than the true temperature of the surface. Thermocouples made by the combination of chromel and constantan wire give electromotive forces 50% greater than the electromotive force given by a copper-constantan thermocouple at the same temperature.

This paper was followed by "Some Observations on Heating Practice," by James Govan, architect, Toronto, Ont., in which several interesting criticisms were leveled at the heating engineer. According to Mr. Govan, heating plants in most cases are designed with 70% to 100% more capacity than needed, which has resulted in increasing building costs.

As illustration of the above, the speaker showed slides, depicting a frame warehouse, a brick school building, and several hospitals, wherein closed hot water heating systems were used. In each case the heating plant and radiating surface was of about double the capacity needed. Mr. Govan's conclusions were based on the consideration that a large error may be introduced into the calculations by failure to consider the periodic character of the heat flow through the walls and roof of a building. As has been pointed out, the resistance to heat flow and the heat capacity of the structure combine to stamp out this wave amplitude. Materials of high heat resistance produce timelag effects that must be taken into consideration in calculating the size of heating plants.

Use of insulation, double and triple glazing was stressed, and the speaker urged that the future of air conditioning in several types of buildings depends upon keeping capital and maintenance costs down.

After the report of the committee on research, delivered by G. L. Larson, professor of mechanical engineering, University of Wisconsin, Edwin C. Evans, Pittsburgh, stated that the burden of financing research was now greater than the society membership could properly carry, and proposed that the society seek foundation pledges with which to carry on the work. Prof. Rowley replied that efforts had been made along these lines with but little success. F. C. Houghten, director of the society's research laboratory at Pittsburgh, then reviewed the accomplishments of the laboratory during the past year.

The entire afternoon session of the first day of the meeting was devoted to revision of the Constitution and By-laws. W. T. Jones, president of the society and chairman of the committee, pointed out the conflicting passages in the old constitution, and explained that the revised constitution was modeled after that of the A.S.M.E. He represented the new constitution as far from perfect, but a good pattern from which to work.

The report of the meeting will be completed in the March issue of HEATING AND VENTILATING.

August Kehm

August Kehm, president of Kehm Brothers Co., Chicago, died December 11, at the age of 64.

Mr. Kehm was a member of the A.S.H.V.E., serving the society as first vice-president in 1909, and as a member of the board of governors from 1908-1911. He was the first treasurer of the Illinois Chapter, holding this office for 24 years. Mr. Kehm was also a member of the Chicago Association of Master Steamfitters, the Heating and Piping Contractors National Association, and the Western Society of Engineers.

Mr. Kehm is survived by his widow and one son, Horace S. Kehm.

New Catalogs

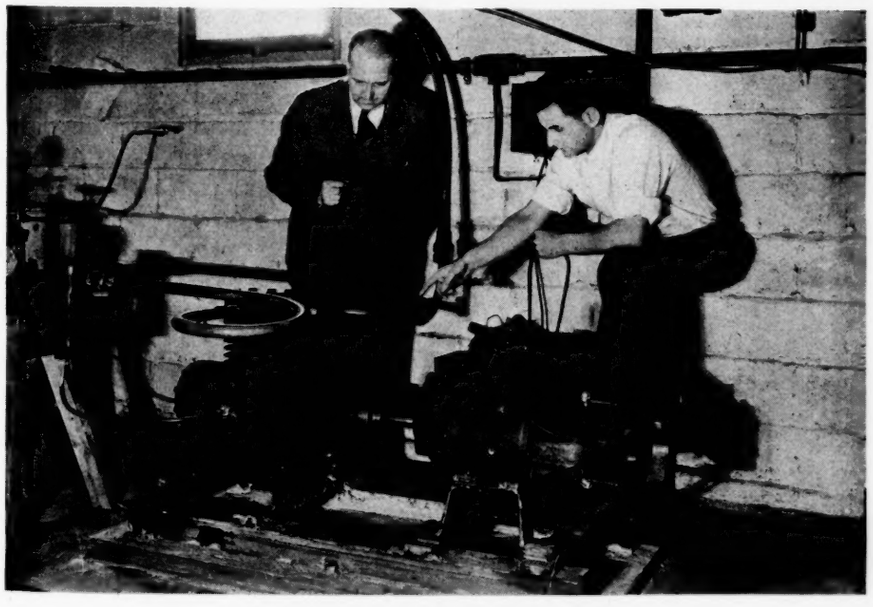
A. M. Byers Co., Clark Building, Pittsburgh, Pa., has issued Bulletin No. 52, entitled "The Theory and Practice of Threading Genuine Wrought Iron Pipe." Various details in workmanship are discussed, and correct methods are described and illustrated; standard size, 23 pages.

Yarnall-Waring Co., Chestnut Hill, Philadelphia, has issued Bulletin EJ-1904 describing the Yarway cylinder-guided expansion joints. The Gun-Pakt method of packing the joint is covered, and dimensional and other engineering data are included; standard size, 16 pages.

Rome Radiation Co., Division of Revere Copper and Brass Inc., Rome, N. Y., has published a catalog descriptive of Robras box fin convectors and Rocop tubular convectors. Contains working data for architects, engineers, and heating contractors; 20 pages, standard size.

Detroit Stoker Co., General Motors Building, Detroit, has issued a bulletin describing multiple retort stokers; standard size, 12 pages.

The Lincoln Electric Co., Cleveland, has issued a bulletin describing the Type D Linc-Weld motor. Contains dimensional data and details of construction; standard size, 4 pages.



ENGINEERS STUDY HEAT PUMP

An actual installation of reversed refrigeration in a residence, made by Westinghouse engineers. The 6-ton compressor cools the 6-room house in the summer and heats it in the winter.

News of the Month

Sarco Co., Inc., 183 Madison Ave., New York, has issued a bulletin describing temperature regulators for heat control in industry. Contains explanation of operation, characteristics, and engineering data; 12 pages, standard size.

The Linde Air Products Co., 30 East 42nd St., New York, has issued a booklet on Oxwelded Piping, covering domestic and industrial heating installations, and industrial piping work; standard size, 18 pages.

Buffalo Forge Co., Buffalo, N. Y., has issued catalog No. 490-C describing Buffalo electric fans for blowing, exhausting, ventilating, cooling, and drying. Illustrated with installation photos; standard size, 16 pages.

Alco Valve Co., 2628 Big Bend Boulevard, St. Louis, has published a text entitled "The Automatic Control of Refrigeration," by H. T. Lange and A. B. Schellenberg, chief engineer and district sales manager, respectively, of the company. Chapter heads include the subjects of filtration, thermostatic and constant pressure expansion valves, high-pressure float valves, electrically-operated valves, control of circulating brine, control of unit coolers, and electrical wiring diagrams. Illustrated with diagrams and photographs of Alco products. Price $1.50, 98 pages, 6 in. x 9 in.

Silent Glow Oil Burner Corp., Hartford, Conn., has issued a booklet entitled "Why We Selected a Silent Glow," describing the complete line of power burners manufactured by the company. Standard size, 12 pages.

The Mercoid Corp., 4201 Belmont Ave., Chicago, has issued catalog No. G-6 describing its line of Federal pressure and vacuum gauges; 12 pages, standard size.

Commodore Heaters Corp., 11 West 42nd St., New York, has issued a booklet entitled "How To Obtain Comfortable Economical Heating." Included topics are: Heating methods of nature; how radiation gives heat; how convection gives heat; what constitutes good heating, and heating the Convecto-fin way; 16 pages, 6 in. x 9 in.

New Equipment

Heat Control Integrates Weather Effects

Superstat Co., 38 Walter St., Springfield, Mass., has developed a control device which automatically integrates the influences of outdoor temperature, wind velocity, and sun effect according to their relationship to heating demand, and thereby operates, through a power unit, a reducing valve to regulate steam supply to conform to heating requirements as specified by the prevailing weather conditions. It is said to effect an important economy in steam consumption when installed as a master control for a group of buildings taking heat from a central source, and the manufacturer states that experience has shown that interior thermostats are unnecessary after the system is once balanced and the correct pressure ratio established.

This instrument, mounted on the roof in such manner as to expose it to wind and sun, acts upon the reducing valve power control so as to adjust it through 26 stages of modulation, 20 of which are dependent upon the direct effect of outdoor temperature upon a thermostatic element, and six of which are controlled by the effect of the wind velocity on a vane. The extent to which these influences are compensated by the sun effect is obtained by the differential between radiant heat absorption and surface dissipation.

Superstat Integrator mounted on roof

For the Atlantic seaboard the apparatus is arranged to cover the entire range of the valve in a temperature range of 65°, providing maximum steam pressure at 0°, but the instrument may also be had to provide a wider temperature range for extremely rigorous climates, where it may be desirable to provide stages of control well below 0°.

Temperature Regulator Adjusts Draft and Check Damper

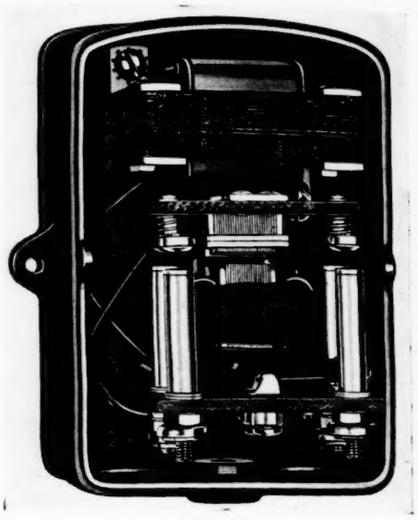
An automatic temperature regulator for adjusting the draft on a hand-fired furnace or boiler to meet the conditions set on a room thermostat is being distributed by Detroit Lubricator Co., Detroit.

Motor unit operates on the lighting circuit and is said to be noiseless. As the thermostat calls for heat, the motor is set into operation and a pivoted arm is swung to open the draft and close the check damper. The fire is checked by a reversed movement of the arm when the thermostat is satisfied. A night and day thermostat with clock for switching the control from one setting to the other may be used in conjunction with the control.

Relay for Two-Wire Low Voltage Control

Automatic Products Co., 121 North Broadway, Milwaukee, Wis., has announced the Model 200 relay for use in conjunction with a thermostat, humidistat, or limit control in starting and stopping motor-driven equipment. The manufacturer recommends it as adapted to the control of air conditioners, stokers, circulators, blowers, etc.

Within the compact case are the transformer for the low voltage current to the room thermostat or other control, and the relay proper, consisting of a double-pole single throw-type switch. Use of a heavy spring insures a sharp make and break of the circuit. Installation work is simplified by the simple two-wire low voltage control circuit. When used with the Model 80T room thermostat, by the same manufacturer, it constitutes the Model 202 relay control set.



Model 200 relay

Electrical rating is 20 amperes at 115 volts, alternating current, and 10 amperes at 230 volts, alternating current. It is suitable for 1-hp. motors of the repulsion induction type, and ½-hp. motors operating split phase.

Thermostatic Control Included with Boiler

An announcement of Spencer Heater Co., Williamsport, Pa., states that hereafter it will supply thermostatic control equipment with coal and gas-fired boilers at no increase in list price of the heaters. Coal-burning boilers will include a Minneapolis No. 40 room thermostat and electric damper motor, and gas-fired boilers will be provided with a Minneapolis No. 77 eight-day clock thermostat.

Gear Reduction Units Built Integrally with Motors

A line of motors having gear reduction units built integrally has been announced by The Ideal Electric & Mfg. Co., Mansfield, Ohio.

Couplings are eliminated as the high-speed gear is mounted directly upon the motor shaft.

Units are available in gear ratios from 2.09 to 1 up to 376 to 1, giving output speeds of from 861 r.p.m. to 4.7 r.p.m., with the standard 1800

Ideal motor-gear unit

r.p.m. motor. For reduction ratios up to 6 to 1 the reducer consists of a single stage helical gear unit, and for ratios up to and including 24.5 to 1 a two-stage helical gear reducer is used. For higher ratios one stage of helical and one stage of heliocentric gears are used. All gears run in an oil bath, and anti-friction ball or roller bearings are used throughout. Motors are supplied in sizes ranging from ¾ hp. to 20 hp., and may be of the open or closed type for either two-phase or three-phase alternating current, or for direct current. Units can also be supplied with motors for two, three, and four speed operation.

Hobart Welder for Plain and Coated Rods

Hobart Brothers Co., Hobart Sq., Troy, Ohio, has announced redesigned arc-welding equipment which is said to provide a 60% increase in capacity over previous models, similarly priced.

Both the coated rod requiring 42 volts and the 25-volt plain rod, can be handled with this welder. Remote control enables the operator to work 50 ft. to 100 ft. away from the unit, with complete regulation of the welding current. Ventilating air is supplied to and discharged from the casing of the welder through louvers on the underside, making it waterproof for use in all kinds of weather. Apparatus is compact and mounted on a sturdy truck for easy portability.

Forced Draft Fan for Domestic Heating System

Universal Blower Co., Birmingham, Mich., is marketing the Universal coal burner, a small blower for automatically supplying controlled forced draft to residential heating boilers and furnaces. The apparatus consists essentially of a motor-driven pressure blower installed in the ash-pit door, and a room thermostat, which regulates the operation of the blower to maintain a uniform predetermined temperature in the living quarters.

Use of the blower makes it possible to burn the cheaper grades of coal. Driven by a 110-volt, 60-cycle induction motor at 3400 r.p.m., the blower will maintain a maximum draft head of 8 in. of water.

Portable Humidifier Evaporates Water Internally

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has announced a portable electric humidifier for domestic and office use.

Air is drawn into the casing where moisture is added to it by evaporation, no mist or liquid water being discharged from the unit. The reservoir, in the lower part of the casing, has a capacity of 3½ gallons, and this water is circulated and filtered at a rate of 100 quarts per hour. The casing is finished in ebony black with silver trim, and is fitted with felt padding on the bottom to protect polished floors and table tops.

Rock Wool Insulation for Residential Buildings

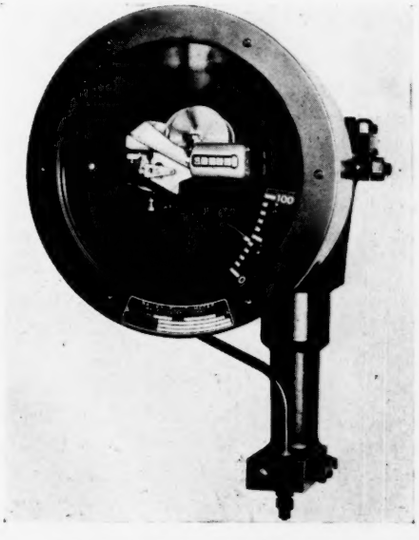
Capitol rock wool insulations, products of The Standard Lime & Stone Co., Insulation Division, First National Bank Building, Baltimore, Md., are said by the manufacturer to be highly efficient in residential buildings for preventing heat loss in winter, and keeping the rooms cooler in summer.

This material is manufactured by a process in which certain rocks are fused at intense heat and blown into minute cellular fibers which are felted together. The material is shipped in rolls, bats, and in the commercial form for insulating new buildings, and in the granulated form for blowing into the walls of existing structures. The insulation is said to be fireproof, moisture-proof, and vermin-proof.

Integrating Flow Meter Designed for Steam Heating Service

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, has developed a flow meter expressly adapted for steam heating service. This instrument is of the indicating and integrating type, since daily record charts are generally not required in this work. Instantaneous flow rate, in pounds per hour, is indicated on the scale, and total flow is integrated and recorded on the six-figure counter.

Flow mechanism operates in accordance with the principle outlined in a previous description of Bailey meters, but the integrating device represents an innovation. A heart-shaped cam, having a uniform angular rise, is geared to a Warren



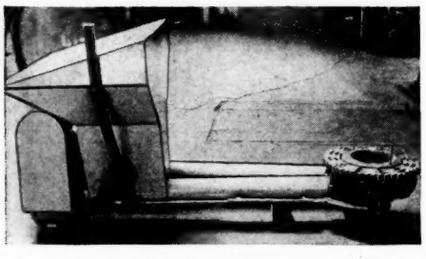
Bailey integrating flow meter

synchronous motor and rotated at the rate of 2 r.p.m. The motor also drives an escape wheel through a friction clutch between the cam and the escape wheel, and a pawl pivoted on the cam-roller arm arrests the motion of the escape wheel or allows it to revolve with the cam, according to the position of the indicating device. When the indicating arm is in the zero position, with no steam flowing, the pawl remains constantly engaged with the escapement wheel, preventing it from rotating with the cam. When the flow indicator is at 100% of capacity, the mechanism operates to keep the pawl disengaged, permitting the escapement wheel to rotate with the cam through the complete 360° revolution. For any fraction of full capacity, the pawl will be disengaged during a corresponding portion of the cam revolution, the resulting integrated flow registering on the counter, which is turned by the escapement wheel. The mechanism is therefore adjusted to the prevailing rate of flow four times each minute.

Flow meter may be used with a maximum demand meter, in which case contacts are mounted on the end of the integrator shaft to record the passage of a given amount of steam.

Stoker Has Circulation and Washing Facilities

An automatic stoker for use with any type of domestic heating plant and which when used with a warm-air system provides circulating, air washing, and humidification facilities, has been announced by the Mechanical Stoker Corp., 401 Schroyer Ave., S.W., Canton, Ohio.



Stokaire, side view

This is an underfeed type of stoker, the fuel being carried into the retort by a screw conveyor, driven through an automatic safety clutch. The fire is carried on a rocking and dumping grate actuated by a shaker handle. A forced draft is provided, and when used with warm-air heating systems, air is propelled into the air chamber as well, improving circulation. An automatic humidifier is also incorporated with the stoker for washing and humidifying the air for warm-air plants.

Vacuum and Vent Valve Combined

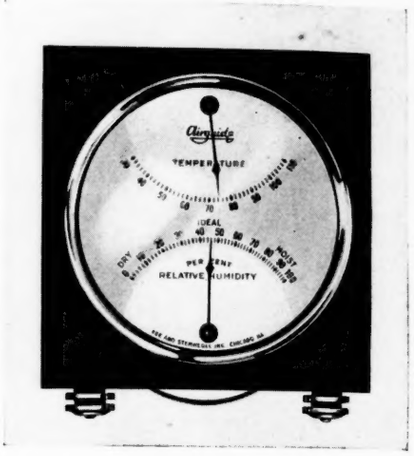
W. A. Russell & Co., Grand Central Terminal Building, New York, is introducing the Warco Master 2M vacuum radiator venting valve. The device consists of a venting valve and a vacuum valve, each operating independently, and enclosed in the same shell.

Air is vented from the radiator through the lower or venting section of the valve which closes instantly as steam reaches it. As the system cools and a vacuum is created by condensation, the vacuum bellows, operating on a fraction of an ounce of pressure differential, is pushed downward by the atmospheric pressure, sealing the valve against the return of air. Maintenance of a high vacuum results in unobstructed circulation of hot vapors throughout the system. The manufacturer states that cold radiators are rapidly and noiselessly heated, and that the air is securely locked out with a minimum of pressure at the boiler.

Instrument Indicates Temperature and Humidity Directly

Fee and Stemwedel, Inc., 221 West Chicago Ave., Chicago, is manufacturing the Airguide, a portable direct-reading combination thermometer and relative humidity indicator for comfort air conditioning work.

Instrument is enclosed in a black bakelite case of modern design with chromium bezel and ornamental feet. Temperature and humidity are indicated on an attractive dial beneath a convex crystal. The case is 4⅝ in. wide, 4¾ in. high, and 1½ in. deep. The humidity sensitive element is a spiral of hygroscopic and non-hygroscopic materials, linked to the pointer so as to record the differential of expansion between the two as affected by the relative humidity. The relative



Airguide temperature and humidity indicator

humidity range of the instrument is from 0% to 100%, and the thermometer indicates temperatures between 30° and 110°. The manufacturer states that these readings are accurate within 3% and 2° respectively.

Brown Flow Meters Made in Several Combinations

A series of mechanical flow meters has been added to the line of fluid measuring devices manufactured by The Brown Instrument Co., Philadelphia, Pa. These meters have been developed into a number of combinations, including those for square root and evenly divided charts, automatic planimeters, automatic control and recording, multipen for pressure, temperature, and flow, and meters with compensation for pressure and temperature.

Mechanism is built into a die cast aluminum case which is attached to the manometer assembly by means of a three-armed bracket which also supports the high and low pressure chambers of the manometer. The high pressure chamber

is a drawn steel cup and the low pressure chamber is a seamless steel tube. A steel U-tube connects the two. The float is so designed that relative motion between it and the mercury surface is prevented, and the position of the mercury surface is accurately transmitted through the linkage to the recording movement. These linkages are simple and direct, and permit an accurate calibration which remains unchanged when the manometer assembly is drained and taken apart for cleaning.

Kitchen Range Supplies All Heat for Home

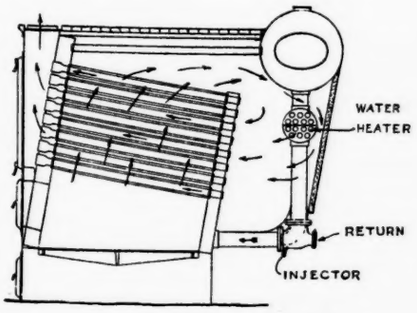
An anthracite-burning kitchen stove which, besides furnishing heat for cooking and hot water, is capable of heating a six-room house, has been developed by the Jeddo-Highland Coal Co., Hazleton, Pa.

Two fire-boxes are provided, both of which are connected with the heating system, but the cooking unit alone is adequate for all purposes excepting in severe weather. The heating system consists of ducts and outlets in the living quarters, from which warmed and humidified air from the stove is circulated by forced draft. Electrically operated forced draft is provided for rapid starting, and ashes are removed automatically.

The stove is carefully insulated to permit the concentration of heat, and to prevent overheating of the kitchen.

McKee Quick-Steaming Compound Boiler

Boiler Repair Maintenance Co., Inc., 632 West 130th St., New York, is manufacturing the McKee compound boiler for heating systems.



Side elevation of McKee compound boiler

This is a combination fire-tube and water-tube boiler, constructed with staggered rows of concentric tubes. Outer tubes are 3½ in. in diameter, and inner tubes are 2½ in. in diameter, providing a thin water space between two directly heated surfaces. The forward end of the smaller tubes is expanded so that both tubes can be withdrawn and replaced through openings in the header. Steam is generated at a rapid rate and passes upward through the inclined tubes, sweeping the heating surfaces clear of air and steam bubbles, preventing corrosion and pitting. An injector placed at the return connection in the lower part of the boiler circulatory system is said to create a vacuum on the return lines which actually shows a lower water level in the system than in the boiler.

An auxiliary drum, located in the rear part of the boiler, provides for the installation of copper coils for heating water. This drum is surrounded by the hot gases of combustion.

Bernard Gardner, 44 Whitehall St., New York, is distributor for the boiler in the New York territory.

Circulating Heater Uses Stove Burners

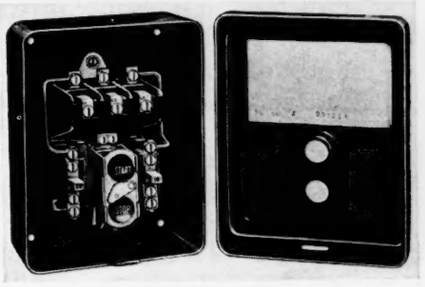
Gilbert & Barker Mfg. Co., Springfield, Mass., is marketing a circulating warm air room heater.

Two G. & B. stove burners supply the heat. A three-gallon oil reservoir bottle, concealed in a metal cabinet at the rear of the heater, supplies the fuel. A large mica-backed grille door permits easy access to the burners for lighting. The heater is enclosed in a metal cabinet finished with two coats of grained mahogany enamel. Units are made in two sizes: type ST1-1 for use in average homes having up to 6500 cu. ft. of space, and type ST2-1 for use in halls, stores, warehouses, etc., up to 9000 cu. ft.

Hand-Operated Starting Switch for A. C. Motors

A compact manually-operated switch that will start and stop small alternating current motors and give overload protection has been developed by Allen-Bradley Co., 1311 South 1st St., Milwaukee, Wis.

Switch is closed or opened by pushing the two buttons extending through the cabinet cover. Pushing the starting button moves the contactor arm upward with a quick snap, making contact with the overhead terminal block and closing the



Allen-Bradley switch

circuit. The tripping of either of the two overload relays with which the switch is provided disengages the contactor arm from the starting button and forces the contacts apart by spring pressure. The button marked "stop" is also the reset button for the relays. When it is pushed in, the tripped relay is reset and the contactor arm is reengaged with the starting button. Double break silver-to-silver contacts eliminate the need for flexible connectors and reduce maintenance of the contacts.

Scott-Newcomb Announces Small Burner

Scott-Newcomb, Inc., St. Louis, Mo., has added a smaller model to its line, to be designated the Pioneer model CJ. It is similar in design to the larger burners of this manufacturer.

Mechanical features include a cut-off valve located at the nozzle to prevent after-dripping, a silent non-leaking pump capable of raising oil 20 ft., continuous ignition, double filtering oil cleaner, stainless steel nozzle, and a noiseless safety control panel. It is finished in black and silver, and insulated against transmission of sound through supports. Capacity ranges from 1½ gal. to 3 gal. per hr., and will take care of from 250 sq. ft. to 1000 sq. ft. of equivalent direct steam radiation.

Degree Days for Present Heating Season Running Well Above Last Year

December, 1932

Addition of the December degree days to the previous totals for the present heating season indicates that fuel consumption for building heating should be considerably higher than last year. The increase was noticeable over the whole country, excepting the far west, which is experiencing a milder winter. Southern cities show the greatest percentage rise, but due to the naturally larger population and normal number of degree days, the east and middle west increases are the most important.

Seattle, San Francisco and Los Angeles report 8%, 30% and 35% warmer seasons (to Dec. 31) than last year. Southern communities are experiencing weather which has resulted in nearly double the number of degree days as compared with last year. The greatest change in the middle west is shown in St. Louis, with a 73.5% rise over the previous heating season. In the east Baltimore reports a 48% increase, while Boston is running only 12.7% above last year.

Degree day figures for December, together with cumulative totals for the present season, last season, and normal, are shown below, as are the unit fuel consumption data for the month of December. The tables in the next column show the change in the present heating season (to December 31) as compared with last year.

EAST	
New York	+ 27.2%
Philadelphia	+ 38.4
Boston	+ 12.7
Buffalo	+ 29.8
Baltimore	+ 48.0
Pittsburg	+ 37.0
MIDDLE WEST	
Chicago	+ 57.5%
St. Louis	+ 73.5
Kansas City	+ 67.0
Minneapolis	+ 43.7
Cincinnati	+ 54.5
Cleveland	+ 24.9
Detroit	+ 41.4
Indianapolis	+ 60.5
Louisville	+ 64.8
Des Moines	+ 57.5
SOUTH	
New Orleans	+ 248%
Atlanta	+ 73.4
Birmingham	+ 100
Memphis	+ 97.0
FAR WEST	
Denver	+ 18.5%
Seattle	— 8.1
San Francisco	— 30.0
Los Angeles	— 35.0

Degree Days and Unit Fuel Consumption—December, 1932

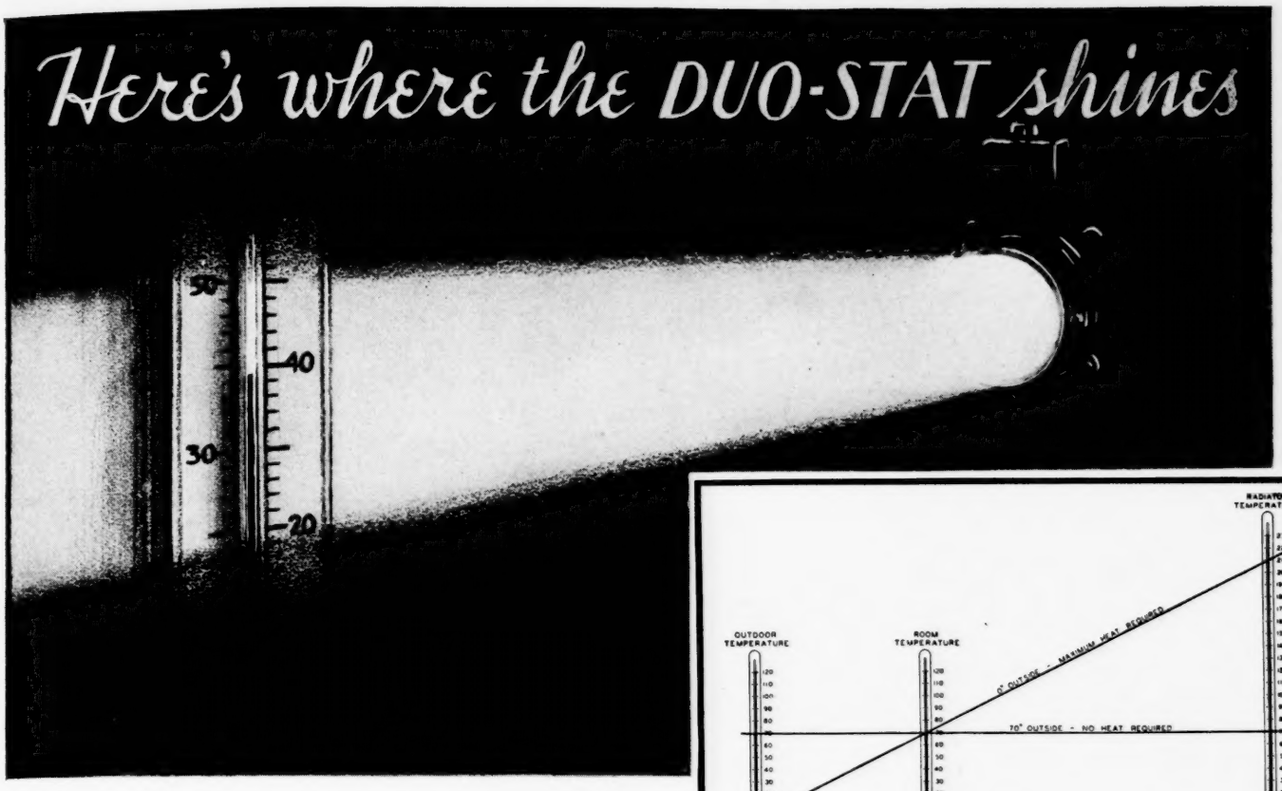
	New York	Seattle	San Francisco	Chicago	Denver	Boston	St. Louis	Pittsburgh
Degree days for Dec. 1932	804	811	544	1120	1280	840	955	909
Degree days, Sept. 1 to Dec. 31, 1932	1733	1779	896	2429	2517	1853	1952	1995
Degree days, Sept. 1 to Dec. 31, 1931	1362	1926	1279	1542	2123	1644	1123	1456
Degree days, Sept. 1 to Dec. 31, Normal	1849	1881	949	2225	2276	2130	1738	1949
Lb. coal/sq. ft. rad., Dec. 1932	6.432	6.488	4.352	8.96	10.24	6.720	7.640	7.272
Gal. oil/sq. ft. rad., Dec. 1932	0.551	0.556	0.373	0.768	0.878	0.576	0.655	0.623
Cu. ft. gas/sq. ft. rad., Dec. 1932	77.18	77.86	52.22	107.52	122.88	80.64	91.68	87.26

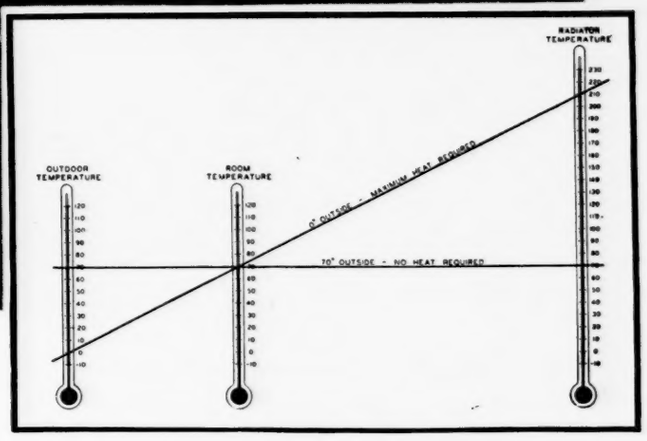
	Los Angeles	Baltimore	Philadelphia	New Orleans	Atlanta	Cleveland	Cincinnati	Detroit
Degree days for Dec. 1932	314	746	761	247	544	967	958	1100
Degree days, Sept. 1 to Dec. 31, 1932	358	1553	1556	549	1208	2085	2014	2392
Degree days, Sept. 1 to Dec. 31, 1931	550	1049	1124	158	697	1670	1304	1692
Degree days, Sept. 1 to Dec. 31, Normal	424	1664	1733	403	1131	2185	1784	2332
Lb. coal/sq. ft. rad., Dec. 1932	2.512	5.968	6.088	1.976	4.352	7.736	7.664	8.800
Gal. oil/sq. ft. rad., Dec. 1932	0.215	0.512	0.522	0.169	0.373	0.663	0.657	0.754
Cu. ft. gas/sq. ft. rad., Dec. 1932	30.14	71.62	73.06	23.71	52.22	92.83	91.97	105.60

	Buffalo	Birmingham	Indianapolis	Memphis	Des Moines	Kansas City	Louisville	Minneapolis
Degree days for Dec. 1932	1017	494	1010	752	1313	1088	876	1494
Degree days, Sept. 1 to Dec. 31, 1932	2321	1080	2215	1428	2821	2186	1813	3239
Degree days, Sept. 1 to Dec. 31, 1931	1788	534	1380	724	1792	1309	1100	2223
Degree days, Sept. 1 to Dec. 31, Normal	2371	913	2002	1127	2370	1809	1587	2941
Lb. coal/sq. ft. rad., Dec. 1932	8.136	3.952	8.080	6.016	10 504	8.704	7.008	11.952
Gal. oil/sq. ft. rad., Dec. 1932	0.697	0.339	0.692	0.516	0.900	0.746	0.601	1.024
Cu. ft. gas/sq. ft. rad., Dec. 1932	97.63	47.42	96.96	72.19	126.05	104.45	84.10	143.42

Fuel consumption figures given above are based on certain conditions, and for other conditions corrections must be made. The figures assume the use of steam radiators emitting 240 B.t.u. per sq. ft. per hr., a system operating at 100% efficiency, and radiators calculated for maintaining 70° in zero weather. Heating values assumed for the fuels are 12,000 B.t.u. per lb. for coal, 1000 B.t.u. per cu. ft. for gas, and 140,000 B.t.u. per gal. for oil. To correct for other heating values, efficiencies, and design conditions, follow the method explained in the "Heating and Ventilating Degree Day Handbook."

Here's where the DUO-STAT shines





Place a ruler through 70° on the room temperature and rotate it to the outdoor temperature. Then read the required radiator temperature.

WHEN outdoor temperature is twenty to fifty degrees... that is when the Duo-Stat is most needed — most effective. And Duo-Stat weather comprises most of the heating season just ahead!

Many heating engineers have found it difficult to believe the ever-growing evidence of big savings produced by the Duo-Stat... and yet these results are founded on principles that are the very mud-sills of modern heating science.

All heating systems are designed so that a radiator temperature of 210 degrees will supply the heat required by a building when it is zero outdoors. Upon this basis the chart above shows what radiator temperatures should be at all other outdoor temperatures.

Is there any heat control system, other than the Duo-Stat, which directly uses this relation in controlling a steam heating system? Can any system that ignores the basic principles of heating practice be expected to achieve real Duo-Stat control?

The best answer is the record of the Duo-Stat —the most conclusive records ever achieved by a heat control.

In practice the Duo-Stat has exceeded the results that its sound principle would indicate. It has been proved beyond a vestige of doubt that the Duo-Stat produces even distribution of heat, and heat modulation in mild weather that cannot be duplicated by elaborate systems costing many times more than the simple, single-instrument Duo-Stat system.

The Duo-Stat is not a prima donna. It is as much at home on a one-pipe system as on the most elaborate two-pipe system. Let us explain why it *does* put the brakes on a sub-zero system—why it *does* accomplish partial filling—why it *does* accomplish even distribution—why it *does* save fuel that otherwise would be wasted in overheating. We will not only explain it; we will *prove* it by operating data.

F. I. RAYMOND COMPANY, 629 W. Washington Blvd., Chicago, Ill.

RAYMOND

DUO-STAT